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# NUCLEAR SCIENCE ABSTRACTS

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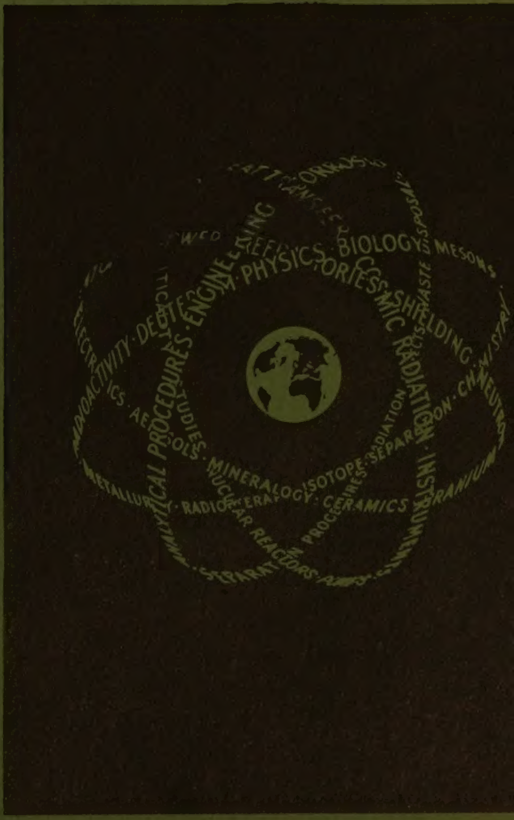

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# NUCLEAR SCIENCE ABSTRACTS

*A Semimonthly Publication of the United States Atomic Energy Commission Technical Information Service*

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*Nuclear Science Abstracts (NSA)* serves scientists and engineers interested in the field of atomic energy by providing abstracts of the literature on nuclear science and engineering as well as immediate and detailed indexes to that literature.

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## ARRANGEMENT OF ABSTRACTS

Abstracts are arranged according to broad subject categories as illustrated by the Contents (page iii). A new system of subject categories has been introduced in Volume 14.

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The indexes included in the individual issues are cumulated quarterly, semi-annually, and annually. A cumulated report number, author, and subject index covering Vols. 1 through 4 (July 1948–1950) is included in the bound Vol. 4 which is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. ($6.00). A subject and author index covering Vols. 5 through 10 (1951–1956) is available from the Superintendent of Documents ($5.25).

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## AVAILABILITY OF PUBLICATIONS ABSTRACTED

Journal articles, books, and other privately published materials are not available from the AEC. Detailed information on obtaining reports and translations is given in the introduction to the Report Number Index.

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*Use of funds for printing this publication approved by the Director of the Bureau of the Budget February 3, 1959.*

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# CORRECTIONS

NSA Vol. 14, No. 3, p. 299. In abstract 2262, in the title, "Proceedings of the Second Annual Meeting . . . should be "Proceedings of the Fourth Annual Meeting . . .

NSA Vol. 14, No. 6A, p. 639. In abstracts 5002 and 5003 Intern. J. Radiation Biol. 4, should be Intern. J. Radiation Biol. 1.

NSA Vol. 14, No. 6A, p. 645-6. In abstracts 5049, 5050, 5051, 5052, 5053, and 5054 Intern. J. Radiation Biol. 4, should be Intern. J. Radiation Biol. 1.

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# NUCLEAR SCIENCE ABSTRACTS

Volume 14 Number 11 June 15, 1960

## GENERAL AND MISCELLANEOUS

**10254** AECU-4438
Michigan. Univ., Ann Arbor.
ACTIVATION ANALYSIS; NUCLEAR CHEMICAL RESEARCH; RADIOCHEMICAL SEPARATIONS. Progress Report No. 8 for November 1958—October 1959. R. S. Maddock and W. W. Meinke, eds. Nov. 1, 1959. 134p. Project No. 7. Contract AT(11-1)-70. OTS.

Activities at the Michigan Reactor and pneumatic tube system are outlined. Various modifications including installation and operation of a "bunny" rabbit pneumatic tube system for transferring samples from laboratory to counter are described. Preliminary investigation for design of a neutron generator for activation work is described. Modifications to the 100-channel pulse-height analyzer including addition of auxiliary circuits and additional detectors are summarized. In nuclear chemistry a cyclotron bombardment to produce long-lived vanadium tracer for yield determinations in activation analysis is described. Summaries of project work which have been published on absolute (d, alpha) reaction cross sections and excitation functions, use of computers in nuclear data analysis, and research on $Ir^{198}$ are presented. Study of the gamma spectra of 33-second $Kr^{90}$, 41-second $Xe^{139}$, and some longer-lived fission product rare gases is reported and a summary of preliminary results is given. Detection of a long-lived isomer of $Ag^{108}$ in old $Ag^{110m}$ samples is reported and new values for the branching ratios of 2.4-minute $Ag^{108}$ are given. Activities of the Subcommittee on Radiochemistry are summarized. Development of a radiochemical procedure by the use of amalgam exchange is reported and exchange of the elements Cd, Tl, Zn, Pb, Bi, Sr, In, and Sn was demonstrated. Methods of expressing the efficiency of radiochemical separations are defined and presented tabularly. Application of activation analysis for many types of systems is reported. Data from activation analysis for trace constituents in meteorites, vanadium in petroleum process streams and in petroleum catalysts are presented. Activation analysis of niobium, rhenium, gold, and thallium are also described. Information on personnel, published reports, and committee meetings is included. (For preceding period see AECU-3887.) (J.R.D.)

**10255** AERE-Lib/L-1(3rd Ed.)
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
SOURCES OF INFORMATION IN ATOMIC ENERGY. L. J. Anthony. Jan. 1960. 44p. BIS.

A list of the depository libraries and published literature containing information on atomic energy in various countries is contained. (C.J.G.)

**10256** BNL-560
Brookhaven National Lab., Upton, N. Y.
ANNUAL REPORT. July 1, 1959. 219p.

The national laboratory concept, laboratory objectives, the staff, research facilities, research activities, and administration are discussed in general terms and a financial statement is given. Fairly detailed accounts are given for the research programs in the fields of physics, accelerator development, instrumentation, applied mathematics, chemistry, nuclear engineering, biology, and medicine. (W.D.M.)

**10257** KAPL-1696
Knolls Atomic Power Lab., Schenectady, N. Y.
REPORT OF THE CHEMISTRY AND CHEMICAL ENGINEERING SECTION FOR NOVEMBER, DECEMBER, 1956, JANUARY 1957. Decl. Feb. 24, 1960. 65p. Contract W-31-109-Eng-52. OTS.

A test facility for the continuous electrolytic destruction of $HNO_3$ wastes is described and its operation reported. The chemical processing of Fast Oxide Breeder mixed oxide fuel is discussed. The nuclear properties of the Cm daughters of Cf were confirmed. Data on the preparation and properties of $PuF_6$ are reviewed, and studies of the rate of decomposition of $UF_6$ on stressed Al are reported. The corrosive effects of $UO_2$—NaK slurries on stainless steel were investigated. Development of an electrorefining process for U continued and container materials for the process were sought. The data from the completed second phase of the subcooled burnout study are given. (For preceding period see KAPL-1620.) (T.R.H.)

**10258** SC-4391(RR)
Sandia Corp., Albuquerque, N. Mex.
CRATER SCALING LAWS FOR DESERT ALLUVIUM. A. J. Chabai. Dec. 1959. 26p. OTS.

Available data indicate that scaling laws derived from dimensional analysis of cratering phenomena are not reliable for predicting crater dimensions over wide ranges of charge weight. A strictly empirical analysis of data from experiments in Nevada desert alluvium provides an estimate of the degree to which various crater parameters deviate from conventional cube-root scaling. Incorporating this deviation from cube-root scaling and assuming a particular equivalence between high explosives and nuclear explosives, crater dimensions for nuclear explosives are predicted at various depths of burst ($0.1 < \lambda_D < 2$). Apparent crater volumes in desert alluvium scale approximately as charge weight to the 0.9 power. As a result, apparent crater volumes from a megaton explosive may be as much as 50 per cent less than those predicted by the scaling of dimensional analysis. Also, depth of burst for maximum crater dimension is found to be proportional to the 0.3 power of charge weight. The problem of extrapolating data from high explosives for prediction of cratering effects of nuclear explosives is examined and some difficulties in this procedure are outlined. (auth)

**10259** SC-4405(RR)
Sandia Corp., Albuquerque, N. Mex.
SOIL MECHANICS CONSIDERATIONS PERTINENT TO PREDICTING THE IMMEDIATE AND EVENTUAL SIZE OF EXPLOSION CRATERS. Robert V. Whitman. Dec. 1959. 29p. OTS.

In some soils and rock formations of interest, deviations from cube-root scaling are to be expected where nuclear explosives are used to form craters. This is significantly true in the case of soft clays and with stronger clays and saturated sands. Inasmuch as underground nuclear explosions to date have been limited to one type of soil, this paper applies some of the ideas of soil mechanics to guide extrapolations to other media. (auth)

**10260** TID-85(2nd Rev.)
Technical Information Service Extension, AEC.
REPORT NUMBER SERIES USED BY THE TECHNICAL INFORMATION SERVICE IN CATALOGING REPORTS. Frances E. Stratton, comp. Mar. 1960. 120p. OTS.

A comprehensive list is presented of all research and development report number series used in cataloging reports located in the files of the Technical Information Service Extension, AEC. An alphabetical list is included for each series, identified on each case with the agency using the series to number the reports which it uses. Also included is an alphabetical list of agencies, with a list for each agency of the codes which it has used in numbering reports. (W.L.H.)

**10261** TID-4550(6th Rev.)
Technical Information Service Extension, AEC.
WHAT'S AVAILABLE IN THE ATOMIC ENERGY LITERATURE. Mar. 1960. 46p.

What unclassified atomic energy literature is available, how to locate and use this information, and how this information may be obtained are discussed. Guidance is furnished for locating, obtaining, and using fully the information announced in abstract journals, indexes, bibliographies, and other informational guides issued by the USAEC. (W.D.M.)

**10262** TID-7571
Atomic Energy Commission, Washington, D. C. and Kansas State Coll., Manhattan.
MIDWESTERN CONFERENCE ON THE INDUSTRIAL USES OF ISOTOPES, HELD AT MANHATTAN, KANSAS, FEBRUARY 25-26, 1959. 270p. OTS.

A conference on industrial uses of isotopes was held at Manhattan, Kansas, on February 25 and 26, 1959. Separate abstracts have been prepared on 28 papers presented at this conference. (C.H.)

**10263** TID-7571(p.71-4)
Wichita High School, North Wichita, Kan. Radiation Physics Lab.
ATOMIC ENERGY THROUGH EDUCATION. Jack H. Rogers. 4p.

Atomic energy must first be understood before any study can be made of its uses. High schools and colleges can do this through the medium of education. A few of the uses of atomic energy are now known, and on the horizon are a limitless number of uses yet to be found. Only through training our young people of today to understand atomic energy, and their becoming aware of the unlimited possibilities, can the many peaceful uses of atomic energy become realities. (auth)

**10264** TID-7571(p.75-91)
Michigan. Univ., Ann Arbor. Law School.
RADIOISOTOPES AND THE LAW. Samuel D. Estep. 17p.

The use of radioisotopes can result in great benefits for mankind, both as to health and economics. However, the use of such materials presents significant health and safety risks to the user and perhaps to many others. In most cases the very characteristic which makes radioisotopes unique and therefore so useful makes them dangerous. The dangers are sufficient to have caused government agencies to impose regulations upon their use. A survey is presented for the business executive and engineer of the possible legal consequences of making use of radioisotopes. Not all of these consequences arise from the health and safety problems but those of greatest significance do and attention is directed primarily to this matter. The responsibility of the lawyer is to identify for the user the potential liabilities involved in using such material. (auth)

**10265** TID-7571(p.253-61)
Office of Isotopes Development, AEC.
THE ECONOMIC AND MANAGEMENT IMPLICATIONS OF RADIOISOTOPES. P. C. Aebersold. 9p.

Industrial uses of radioisotopes and radiation are reviewed briefly. Factors that management must consider before deciding to use radioisotopes in plant operations or development studies are discussed. Cost factors involved are outlined. (C.H.)

**10266** TID-7571(p.262-6)
Office of Isotopes Development. Isotope Technology Branch, AEC.
INFORMATION AND EDUCATION FOR INDUSTRIAL USE OF RADIOISOTOPES. P. J. Blaetus. 5p.

Significant publications and services are outlined which are available to anyone interested in acquiring an introduction to the literature of nuclear energy as a whole and applications of radioisotopes in industrial research and development in particular. (C.H.)

**10267** TID-7585(p.171-4)
Liberty Mutual Insurance Co., Boston, Mass.
SOME INSURANCE PROBLEMS RELATING TO THE USE OF NUCLEAR ENERGY. Ashley St. Clair. 4p.

Problems are reviewed which are involved in providing insurance to individuals and corporations against the hazards created by the use of nuclear energy by private organizations. (C.H.)

**10268**
General Motors Inst., Flint, Mich.
RADIOISOTOPES IN INDUSTRY TRAINING PROGRAM. VOLUME II. John P. Danforth and Robert P. Stapp, eds. 1959. 835p. OTS.

An outline is presented for a training program designed to teach professional industrial personnel the basic considerations in the application of radioisotopes to industrial work. (W.L.H.)

**10269**
Organization for European Economic Co-Operation, Paris.
USE OF RADIATIONS AND RADIO-ISOTOPES IN AGRICULTURE AND FOOD. List of Research Institutes and Scientists in O.E.E.C. Member Countries. July 1959. 76p. Project 396. (In English and French)

Research institutes and scientists engaged in studies related to the application of atomic science to agriculture and food are listed for countries of the Organization for European Economic Co-operation. (C.H.)

**10270**
PRINCIPLES OF RADIOISOTOPE METHODOLOGY.
Grafton D. Chase. Minneapolis, Burgess Publishing Company, 1959. 295p.

This book is essentially a laboratory manual written primarily for the beginner in the field of radioisotopes. It is intended to serve as an introductory guide for the technician, the advanced medical student, and the researcher who may find the use of radioisotopes valuable in his work. Practical experiments are included. (C.H.)

# BIOLOGY AND MEDICINE

## General and Miscellaneous

**10271** AD-215284
Michigan State Univ., East Lansing.
CONTROL OF STORAGE ROT OF POTATOES BY GAMMA IRRADIATION. Report No. 10 (Final) for period [covered]: November 5, 1956—June 30, 1958. W. J. Hooker, D. R. Isleib, and D. T. Duncan. 47p. Project No. 7-84-01-002. Contract DA-19-129-QM-291.

Results are reported from a series of studies on the effects of irradiation levels ranging from 5 to 500 kilorep on the storage life of potatoes. Data are included on the radiosensitivity of bacteria causing soft rot in potatoes. (C.H.)

**10272** AD-218285
Armour and Co. Food Research Dept., Chicago.
DEVELOPMENT OF IRRADIATED RATION TYPE MEAT ITEMS. Report No. 5 (Progress) [for] Period July 1, 1958 to August 31, 1958. H. P. Furgal. 25p. Project No. 7-84-01-002. Contract DA-19-129-QM-1049.

The results presented herein include the flavor evaluation after storage of irradiated lots of meat, and the preparation and initial flavor evaluation of newly irradiated test products. The storage temperature was 70 to 75°F. All flavor evaluations were made on a nine point hedonic scale. (auth)

**10273** AD-220046
American Meat Inst. Foundation, Chicago.
A STUDY OF CHEMICAL CHANGES PRODUCED BY HEAT AND BY IRRADIATION OF MEAT AND MEAT FRACTIONS. Report No. 2 (Progress) [for] Period December 24, 1958—March 23, 1959. W. A. Landmann. 4p. Project No. 7-84-01-002. Contract DA-19-129-QM-1293.

Irradiated fresh and irradiated cooked ground round of beef were separated into various fractions. Methanol extraction of the residue remaining after fractionation of irradiated fresh beef gave a substance which contained the characteristic wet dog hair irradiation odor. Results of various classification tests are given which indicate that this material contains steroids and lecithin. Efforts are being made to identify the entity responsible for this wet dog hair odor. (auth)

**10274** AD-220047
Oregon. Agricultural Experiment Station, Corvallis.
STUDY AND INVESTIGATION OF RADIATION RESISTANT ORGANISMS IN FOOD. Report No. 7 (Progress) [for] Period November 1, 1958 to January 31, 1959. A. W. Anderson. 9p. Project No. 7-84-01-002. Contract DA-19-129-QM-1055.

Heat survival curves were determined for the nonsporeforming radiation resistant cocci ($R_1$) and rod ($M_1R$). It appears that these curves approximate the straight line relationship of logarithmic order of death. The Z value obtained was determined in special beef preparation. The value obtained for $R_1$ was 11. This falls within the usual range of 10 to 14 observed for vegetative cells. No well defined results could be obtained for $M_1R$, however, the limited data available indicate that this organism is more sensitive to heat than the $R_1$. (auth)

**10275** AD-220079
American Meat Inst. Foundation, Chicago.
A STUDY OF CHEMICAL CHANGES PRODUCED BY HEAT AND BY IRRADIATION OF MEAT AND MEAT FRACTIONS. Report No. 1 (Progress) [for] Period September 24—December 23, 1958. W. A. Landmann. 7p. Project No. 7-84-01-002. Contract DA-19-129-QM-1293.

Fresh and cooked ground rounds of beef were separated into various fractions, and solutions of these fractions were irradiated. Both irradiated and non-irradiated solutions were analyzed for the presence of hydrogen sulfide, methyl mercaptan, acid-soluble carbonyl compounds, and non-volatile sulfhydryl groups, as in glutathione. The production or disappearance of these compounds was found to occur only in certain meat fractions upon irradiation. (auth)

**10276** AD-220080
Department of Agriculture. Western Utilization Research and Development Div., Albany, Calif.
RADIATION PRESERVATION OF POULTRY PRODUCTS. Report No. 2 (Progress) [for] Period September 1, 1958—November 30, 1958. Hans Lineweaver. 4p. Project No. 7-84-01-002.

Data are tabulated from studies on the effects of combined irradiation and heat processing procedure for chickens. Irradiation of young chickens caused a marked loss in strength in the subsequently cooked or reheated bones. (C.H.)

**10277** AD-220153
Armour and Co. Food Research Dept., Chicago.
USE OF ANTIBIOTICS AND/OR CHEMICAL ADDITIVES IN COMBINATION WITH RADIATION TO PRESERVE FRESH MEAT ITEMS. (Progress) Report No. 9 [for] July 1, 1958 to December 31, 1958. C. K. Wiesman. 6p. Project No. 7-84-01-002. Contract QMRD (Natick) No. 38 (Agreement).

Data are summarized from studies on the effects of radiation on the shelf life and acceptability of precooked pork sausages. (C.H.)

**10278** AD-220154
Armour and Co. Food Research Dept., Chicago.
DEVELOPMENT OF IRRADIATED RATION TYPE MEAT ITEMS. Report No. 6 (Progress) [for] Period September 1, 1958 to October 31, 1958. H. P. Furgal. 18p. Contract DA-19-129-QM-1049.

Progress is reported in an evaluation of flavor after irradiation and storage of pork and gravy, chicken and gravy, sliced precooked beef, beef stew, barbecued chicken, and barbecue sauce. (C.H.)

**10279** AD-220487
Morrell (John) and Co., Ottumwa, Iowa.
THE EFFECT OF PASTEURIZING AND STERILIZING DOSES OF GAMMA RAYS ON THE KEEPING QUALITY OF PROCESSED MEATS. Report No. 9 (Progress) [for] August 1, 1958—October 31, 1958. W. L. Brown. 4p. Project No. 7-84-01-002. Contract QMRD (Natick) No. 51.

Progress is reported in studies on the effect of sterilizing doses of radiation on the flavor and keeping qualities of bacon produced by seven packers. Data are tabulated. (C.H.)

**10280** AECU-4731
Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica.
THE APPLICATION OF NUCLEAR ENERGY TO AGRICUL-

TURE. Annual Report. Mar. 1, 1960. 50p. Contract AT(30-1)-2043. OTS.

A training program is reported in the use of radioisotopes as tracers and in pure and applied genetics. Results are summarized from a series of tracer studies on plant metabolism. (C.H.)

**10281** CEA-1215
France. Commissariat à l'Énergie Atomique, Paris.
TECHNIQUE D'AUTORADIOGRAPHIE A TRES BASSE TEMPERATURE. (The Technique of Autoradiography at Very Low Temperature). P. Pellerin. 1959. 8p.

Biological samples frozen in liquid nitrogen (−195°C) acquire the hardness of light metals, enabling the surface for autoradiography to be cut on a milling machine. The autoradiographic exposure is made in saturated nitrogen vapor. The emulsion, on a plastic base, is laid on the milled surface in a dark room and this assembly is then placed above the liquid nitrogen in a foam-teflon container. Measurements show that a temperature gradient is established between −190° at the liquid nitrogen surface and −120° at the top of the closed container. Developing is done at room temperature, the speed of the emulsion being practically unchanged. This technique enables the specimen to be kept far below the freezing-point, from the moment the animal is killed until the plate is developed. Freezing ensures complete absence of chemical diffusion and that the recorded tracer distribution is precisely that obtaining at the time of death. The distribution at different levels can be investigated by milling off successive layers. Pseudo-radiographic effects are wholly non-existent. The enhancement of natural colors in the anatomical elements, brought about by low temperatures, is such that it becomes possible to dispense with straining when making color autoradiograms of sections. (auth)

**10282** SRIA-13
Stanford Research Inst., Menlo Park, Calif.
RADIOISOTOPES IN MEDICINE. Richard R. Tarrice and Mark S. Blumberg. Dec. 1959. 187p. SRI Project No. IU-2567. Contract AT(04-3)-115. OTS.

The Atomic Energy Commission has sponsored training, research grants, subsidies, and information programs in the field of nuclear medicine. Workers in the field of nuclear medicine have seen a remarkable growth in the availability of radiomaterials within the past thirteen years. The major source of this supply has been Oak Ridge National Laboratory. This production facility has made in excess of 130,000 shipments of radioisotopes valued at more than $18 million. One-half of this has been for use in the medical profession. Data are summarized on medical uses of isotopes in the United States. 135 references. (C.H.)

**10283** TID-7571(p.150-5)
Kansas State Coll., Manhattan.
APPLICATION OF GAMMA RADIATION TO GRAIN STORAGE AND TECHNOLOGY. Max Milner. 6p.

Gamma irradiation in the range 16,000 to 65,000 rep kills insects in stored wheat; doses somewhat beyond 250,000 rep will destroy fungi which cause spontaneous heating and chemical degradation. The latter treatment eliminates seed germination and produces pronounced physical and biochemical alterations in the grain and its products, which are reflected in modified baking properties. Changes observed include extensive degradation of starch, loss of imbibitional capacity of gluten, darkening of flour and increase in fluorescence, changes in dough physical properties and response to oxidizing improvers, production of off-flavors and stimulation of bread staling. Increases in loaf volume due to irradiation are observed which are minor compared with the effects of oxidizing agents, sugar, or sugar-producing additives. The implications of this information to the application of gamma radiation to the storage, handling, and utilization of wheat are discussed. (auth)

**10284** TID-7578
Associated Midwest Universities, Lemont, Ill. and Argonne National Lab., Lemont, Ill.
OKLAHOMA CONFERENCE—RADIOISOTOPES IN AGRICULTURE, HELD APRIL 2 AND 3, 1959, OKLAHOMA STATE UNIVERSITY, STILLWATER, OKLAHOMA. 292p. GPO.

A Conference on Radioactive Isotopes in Agriculture, sponsored by Associated Midwest Universities and Argonne National Laboratory, was held at Oklahoma State University, Stillwater, Oklahoma, April 2 and 3, 1959. Separate abstracts have been prepared on 22 papers presented at this conference. (C.H.)

**10285** TID-7578(p.9-22)
Brookhaven National Lab., Upton, N. Y.
THE DESIGN OF A HIGH INTENSITY COBALT-60 FOOD IRRADIATOR. Otto A. Kuhl. 14p.

General specifications for high-intensity food irradiators are reviewed. Design features of one cobalt-60 food irradiator are described. Results of final experiments and design information obtained from scale-up calculations are summarized. (C.H.)

**10286** TID-7578(p.23-6)
Argonne National Lab., Lemont, Ill.
THE PROBLEMS OF TESTING CHANGES IN LOW FREQUENCY EVENTS IN HUMAN POPULATIONS. Harry Auerbach. 4p.

Current concern about possible effects of fall-out has led to marked differences of opinion between the groups postulating a threshold effect and those concluding the effects are linear, or proportional, at all levels of exposure. The difficulties inherent in testing for possible effects in human populations are discussed. (C.H.)

**10287** TID-7578(p.61-8)
Argonne National Lab., Lemont, Ill.
TRACER STUDIES OF METHIONINE METABOLISM. F. Schlenk and S. K. Shapiro. 8p.

Methionine occupies a special position among amino acids because it has several important functions aside from its position as a structural unit of many proteins. The principal metabolic reactions in which it participates include protein synthesis, conversion into cysteine via homocysteine and cystathionine, sulfur precursor of miscellaneous cellular constituents, and as a constituent of machylsulfonium compounds which are important in transmethylation and other processes of group transfer and formation. Results are reported from tracer studies of methionine metabolism. (C.H.)

**10288** TID-7578(p.69-75)
California Inst. of Tech., Pasadena.
HIGH RESOLUTION AUTORADIOGRAPHY. J. Herbert Taylor. 7p.

Methods are described for the preparation and evaluation of high-resolution radioautograms of biological materials. (C.H.)

**10289** TID-7578(p.97-103)
Missouri. Agricultural Experiment Station, Columbia.
A CRITIQUE OF INDICES OF THYROID GLAND FUNCTION. C. W. Turner, G. W. Pipes, and B. N. Premachandra. 7p.

Three indices of thyroid gland function; namely, thyroid gland uptake of $I^{131}$, rate of release of thyroidal-$I^{131}$, and estimation of thyroxine secretion rate, have been proposed. Studies involving these indices are reviewed. Reasons are given why it is believed that the first two indices fail to reflect the true rate of thyroxine secretion. Details of the methods evolved for direct quantitative estimation of the thyroxine secretion rate are presented for those wishing to use the method. (auth)

**10290** TID-7578(p.113-21)
Idaho Operations Office, AEC.
IODINE METABOLISM IN WILD JACK RABBITS. Norman R. French. 9p.

Results are reported from studies of iodine metabolism and levels of iodine-131 in wild jack rabbits at the National Reactor Testing Station site. The thyroid activity of the rabbits is compared with that of chipmunks and kangaroo rats from the same site. (C.H.)

**10291** TID-7578(p.123-9)
California Inst. of Tech., Pasadena.
AUTORADIOGRAPHIC STUDIES OF CHROMOSOME DUPLICATION AND STRUCTURE. J. Herbert Taylor. 7p.

Results are reported from radioautographic studies of chromosome duplication and structure in which tritiated thymidine was used as a selective label for desoxyribonucleic acid. (C.H.)

**10292** TID-7578(p.131-7)
Brookhaven National Lab., Upton, N. Y.
THE USE OF TRITIATED THYMIDINE IN RADIOBIOLOGICAL STUDIES WITH MAMMALIAN CELL CULTURES. Robert B. Painter and Ruth M. Drew. 7p. (BNL-4101).

Results are reported from radiobiological studies with mammalian cell cultures in which tritiated thymidine was used as a tracer. (C.H.)

**10293** TID-7578(p.145-52)
Brookhaven National Lab., Upton, N. Y.
AUTORADIOGRAPHIC STUDIES OF RIBONUCLEIC ACID METABOLISM WITH TRITIUM-LABELED CYTIDINE. Philip S. Woods. 8p. (BNL-4154).

The autoradiograph technique in conjunction with tritium-labeled cytidine was used to study ribonucleic acid metabolism in actively dividing cells. It was shown that with continuous treatment radioactive material appeared first in the nucleolus and later in both nucleolus and cytoplasm. In an experiment where the cells were treated long enough so that only nucleoli were labeled, the labeled material was shown to move from the nucleolus to the cytoplasm with further growth in a non-labeled medium. Little radioactive material that could be attributed to RNA appeared in the chromatin portion of interphase nuclei. These observations were discussed in consideration of the hypothesis that RNA is the carrier of genetic specificity from the deoxyribonucleic acid of the chromosomal gene to sites of protein synthesis in the cytoplasm. (auth)

**10294** TID-7578(p.173-80)
Argonne National Lab., Lemont, Ill.
DELAYED PHENOTYPIC EXPRESSION OF MUTATION. Herbert E. Kubitschek. 8p.

Basic factors which may be involved in delayed phenotypic expression of mutations are discussed. Data are included from a study of caffeine-induced mutations in a T5-resistant strain of E. coli. (C.H.)

**10295** TID-7578(p.213-25)
Food and Agriculture Organization of the United Nations, Rome.
PRODUCTION, ABSORPTION AND UTILIZATION OF RUMEN VOLATILE FATTY ACIDS. J. C. Shaw. 13p.

Results are summarized from tracer studies on the production, absorption, and utilization of rumen volatile fatty acids. Data are included from studies on the physiology of mammary gland metabolism and factors affecting milk secretion by ruminants. (C.H.)

**10296** TID-7578(p.253-61)
California. Univ., Davis. [School of Veterinary Medicine].
INTERMEDIARY METABOLISM IN MILK FORMATION; STUDIES ON THE METABOLIC ROLE OF THE UDDER. Max Kleiber, Arthur L. Black, and Jack R. Luick. 9p.

Results are summarized from tracer studies on the role of the udder in milk formation in cows. (C.H.)

**10297** TID-7578(p.263-8)
Veterans Administration Hospital, Oklahoma City.
CHROMIUM-51 LABELED ERYTHROCYTES AS A MEASURE OF HEMOLYSIS. P. C. Johnson, C. Bloedow, and J. Bahr. 6p.

Estimation of the life span of the erythrocyte is an aid in the classification of anemia. Chromium-51 labeled erythrocytes can be used for this purpose. Using the percentage remaining on the eighth day, we have found that a difference of statistical significance can be found between anemia due to hemolysis and those from other causes. The difficulties with this method of estimating erythrocyte life span are discussed. (auth)

**10298** TID-7578(p.269-74)
Veterans Administration Hospital, Oklahoma City and Oklahoma. Univ., Oklahoma City. School of Medicine.
ESTIMATION OF CORONARY BLOOD FLOW BY AN EXTERNALLY PLACED SCINTILLATION DETECTOR. Gunnar Sevelius and Philip C. Johnson. 6p.

A new method for measuring coronary blood flow has been developed. This method makes use of a scintillation detector of monitors on the chest wall and the time dilution curve of radioactivity during its first passage through the heart chambers and through the myocardium. The values obtained compare favorably with the values obtained by standard methods and in a flow model. Significant differences have been found between patients with and without myocardial infarctions. (auth)

**10299** TID-7585
Massachusetts Inst. of Tech., Cambridge.
PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THE PRESERVATION OF FOODS BY IONIZING RADIATIONS, JULY 27–JULY 30, 1959. 294p. Contracts AT(49-9)-1597 and IAEA/STI/2-59. OTS.

A conference on the Preservation of Foods by Ionizing Radiations, sponsored by Massachusetts Institute of Technology, the U. S. Atomic Energy Commission, and the International Atomic Energy Agency, was held at Cambridge, Massachusetts, July 27 through July 30, 1959. Separate abstracts have been prepared on 21 papers presented at this conference. (C.H.)

**10300** TID-7585(p.74-90)
Massachusetts Inst. of Tech., Cambridge.
GENERAL CONSIDERATIONS RELATING TO FOOD IRRADIATION. Bernard E. Proctor. 17p.

Developments in food irradiation are reviewed. Problems encountered are discussed and predictions of future developments are presented. (C.H.)

**10301** TID-7585(p.91-102)
Massachusetts Inst. of Tech., Cambridge.
DIRECT AND INDIRECT EFFECTS OF RADIATIONS. Samuel A. Goldblith. 12p.

Data on the effects of ionizing energy on matter are reviewed. Emphasis is placed on applications in the preservation of food by radiation. Possible means of controlling the undesirable side reactions relating to radiation preservation of foods are considered. (C.H.)

**10302** TID-7585(p.116-23)
Massachusetts Inst. of Tech., Cambridge.
THE EXTENSION OF STORAGE LIFE OF FOODS USING IONIZING ENERGY. John T. R. Nickerson. 8p.

The possibilities of using ionizing radiations for purposes of food preservation and for the prevention of foodborne diseases are mostly confined to treatment at dose levels of less than 1,000,000 rep. Some possibilities of low-dose-irradiation treatment are evident to prevent losses due to the sprouting of onions and potatoes, to eliminate losses in grain and cereal products due to insect damage, to destroy the disease-causing Trichinae in pork, to extend the storage life of flesh-type foods at temperatures between 32 and 40°F, and to destroy the disease-causing Salmonella bacteria in foods and food products. (auth)

**10303** TID-7585(p.155-60)
Ethicon, Inc., Somerville, N. J.
ELECTRON BEAM STERILIZATION. Walton Van Winkle, Jr. 6p.

Commercial applications of electron beams in the sterilization of surgical sutures are discussed. Since some sutures are derived from the connective tissue layers of the intestines of sheep and cattle, and the protein material is sensitive to heat, irradiation sterilization has resulted in a better product. Sterilization can be done in the final sealed container which offers distinct manufacturing advantages. The performance of 7-Mev microwave linear accelerators and of Van de Graaff electrostatic accelerators is discussed. Dosimetry methods and cost factors are discussed. (C.H.)

**10304** TID-7585(p.161-70)
Gt. Brit. Low Temperature Research Station. [Radiation Group]. Cambridge, England.
ADVANTAGES OF IRRADIATING PORK AND BEEF IN THE FROZEN STATE FOR STERILIZATION. M. Ingram, B. Coleby, M. J. Thornley, and G. M. Wilson. 10p.

Results are reported from studies on the effects of irradiating pork and beef in the frozen state on keeping qualities and taste acceptance of the meat. Meat innoculated with spores of Clostridium botulinum required radiation doses about 15% higher for sterilization at −75°C than when exposed at 0°C. Comparisons made by taste panels showed meats irradiated at −75°C were superior in odor and flavor to those irradiated at 0°C. (C.H.)

**10305** TID-7585(p.175-200)
Office of the Quartermaster General, Washington, D. C.
ENGINEERING, HANDLING, AND TRANSPORTATION OF PILOT PLANT SOURCES. R. G. H. Siu. 26p.

Possible sources of ionizing radiations for use in pilot plant food irradiation facilities are surveyed. Sources used in pioneering research on food irradiation are described. The potentialities of the linear accelerator for electrons, the gamma-producing reactor, and cobalt-60 for gamma rays are discussed. Developments are outlined in plans for the construction of a pilot production plant for irradiation of foods. (C.H.)

**10306** TID-7585(p.210-11)
[Szkola Glowna Gospodarstwa Wiejskiego], Warsaw. Instytut Przemyslu Mleczarskiego.
ACTUAL RESEARCHES ON THE USE OF IONIZING RADIATIONS FOR FOOD PRESERVATION IN POLAND. Wladyslaw Bednarczyk. 2p.

Results are reported on applications of ionizing radiations for the inhibition of the sprouting of potatoes and onions and in the dairy industry. Researches on the use of ionizing radiations for food preservation are summarized. (C.H.)

**10307** TID-7585(p.230-3)
Germany. Bundesforschungsanstalt für Lebensmittel-Frischhaltung, Karlsruhe.
RESEARCH ACTIVITIES IN THE FIELD OF FOOD PRESERVATION BY IRRADIATION IN GERMANY. J. Kuprianoff. 4p.

Research is reported on radiation dosimetry in foodstuffs, the radiosensitivity of some food spoilage microorganisms at various water contents in various substances, the biochemical effects of irradiation on selected enzymes, the effects of surface irradiation on foods, and the chemical analysis of the products of irradiation. (C.H.)

**10308** TID-7585(237-43)
[Institut Pasteur]. Centre National De Recherches Zootechniques, Jouy-en-Josas, France.
LES RECHERCHES EN COURS ET LES RECHERCHES PRÉVUES EN FRANCE CONCERNANT L'UTILISATION DES-RADIATIONS IONISANTES POUR LA PRÉSERVATION DES ALIMENTS. (Current and Future Research in France on the Use of Ionizing Radiation for the Preservation of Food.) G. Mocquot. 7p.

Studies on radiation dosimetry and fundamental bacteriological studies of interest in the preservation of foods by ionizing radiations are reviewed. Sources of radiation available at present are discussed. Studies planned for the future are outlined. (C.H.)

**10309** TID-7585(p.249-56)
National Research Council [of Canada]. Div. of Applied Biology, Ottawa.
GOVERNMENT SPONSORED RESEARCH ON FOOD IRRADIATION IN CANADA. Dyson Rose. 8p.

An interdepartmental committee on food irradiation was established in 1957. Research projects sponsored to date include the effects of irradiation on the storage life of apple juice, anti-sprouting irradiation of potatoes, effects of irradiation on development of rancidity in bacon, effects of irradiation on tocopherol, and the radiosensitivity of Salmonella pullorum and Clostridium botulinum. (C.H.)

**10310** TID-7585(p.257-65)
Argentina. Comisión Nacional de Energia Atomica, Buenos Aires.
REPORT ON THE PROGRAM FOR THE PRESERVATION OF FOODS BY IRRADIATION. Santos Soriano. 9p.

Agricultural resources of the Argentine Republic are reviewed. Developments are summarized in a program for the preservation of food by irradiation. (C.H.)

**10311** TID-7585(p.266-74)
Tokyo Univ.
EFFECTS OF IONIZING RADIATIONS ON FOODS AND ASSOCIATED MATERIALS. Yusuke Sumiki. 9p.

A brief review is presented summarizing studies on the radiation preservation of foods in Japan. About 50 institutes are reported to be equipped with cobalt-60 gamma sources, in addition to medical applicators, and a total of 38,900 curies of cobalt-60 is in use. Data are included from experiments on the effects of radiation on alcoholic beverages, miso, soysauce, lethal effects of radiation on microorganisms, mechanisms of the action of radiation sterilization synergists, chemical effects of radiations on foods and their constituents; denaturation of food protein by gamma irradiation, and the causes of irradiation off-flavors in foods. (C.H.)

**10312** TID-7585(p.278-81)
Australia. Commonwealth Scientific and Industrial Research Organization. Div. of Food Preservation, Homebush, New South Wales.
AUSTRALIAN INVESTIGATIONS ON THE EFFECTS OF IONIZING RADIATIONS APPLIED TO FOODS. J. R. Vickery. 4p.

Developments are reported in an investigation of low dosages of radiation as an adjunct in the preservation of meat and certain fruits. Preliminary studies are reported on factors governing the survival of irradiated microorganisms. (C.H.)

**10313** UMRI-2718-6-P
Michigan. Univ., Ann Arbor. Fission Products Lab.
RADIOPASTEURIZATION OF FOODS. Report No. 6 (Progress) [for] July 21, 1958—September 20, 1958. 10p. Project No. 7-84-01-002. Contract DA-19-129-QM-1069. (AD-219347).

Progress is reported in a study of the effects of various additives on inhibiting off-flavor in irradiated beef. (C.H.)

**10314** USNRDL-TR-375
Naval Radiological Defense Lab., San Francisco.
THE DENSITY OF ORGANIC, VOLATILE AND NON-VOLATILE INORGANIC COMPONENTS OF BONE. J. K. Gong, J. S. Arnold, and S. H. Cohn. Sept. 18, 1959. 20p.

Densities of the various bone fractions i.e., water, organic, volatile inorganic, and ash fractions, as well as fat in various animals have been studied. However, values reported by various workers failed to show consistency and uniformity, especially with respect to the volatile inorganic (often called $CO_2$ fraction) and the ash fractions. These densities are prerequisite to the study of the volumetric composition of bone and bone marrow. In our study, the fat and organic densities found were similar to those previously reported. The volatile and non-volatile inorganic (ash) fractions had density values of 1.684 and 3.18, respectively. The ash density of 3.18 was much higher than values previously reported but it verifies a theoretical value deduced by the authors from published works. Prior to the determination of the density of the non-volatile inorganic fraction, the ashing time and temperatures were studied. Curves plotted from results of such studies were described and explained. (auth)

**10315** USNRDL-TR-392
Naval Radiological Defense Lab., San Francisco.
SIMPLIFIED APPROACH IN CALCULATING TRANSFER RATES IN PERFUSION-EXCHANGE SYSTEMS. B. E. Vaughan and E. L. Alpen. Jan. 7, 1960. 14p.

A simplified approach is described for the problem of evaluating unidirectional transfer rates out of a non-perfused organ or tissue in a perfusion-exchange system. In contrast with strict models, this involves only measurements of specific activity on two sides and a perfusion outflow rate. When dynamic exchange is insignificant, the simplified calculation is exact. The criterion for this is that specific activity of material in the non-perfused compartment is constant in time. When substantial dynamic exchange occurs, the simplified calculation systematically underestimates the transfer rate, and this underestimate depends upon the ratio of specific activities, as is shown by experimental examples for $H^3$-water and for $Na^{22}$. (auth)

**10316**
GENETIC AND AUTORADIOGRAPHIC STUDIES OF TRITIATED THYMIDINE IN TESTES OF DROSOPHILA MELANOGASTER. W. D. Kaplan and J. E. Sisken (City of Hope Medical Center, Duarte, Calif.). Experientia 16, 67-9(1960) (In English)

Autoradiographic studies were made of D. melanogaster larvae at various intervals after removal from a T-containing diet up to 56 hours. The preliminary data show that spermatocytes reduplicate their chromosomes very early and move posteriorly as additional cells are proliferated from the apical spermatogonia. The mutagenic effect of tritiated thymidine was studied genetically. Unquestionably the T produces a mutagenic effect. (T.R.H.)

**10317**
RADIOPROTECTIVE EFFECTS OF APRESOLIN AND C.5864-Su (2-Octahydro-1-azocinylethyl-guanidine). R. Jaques and R. Meier (CIBA Aktiengesellschaft, Basel). Experientia 16, 75-6(1960) (In German)

Mice exposed to a lethal total-body x-irradiation were partly protected by comparatively small doses of 1-hydrazinophthalazine (Apresoline), and even smaller ones of [2-(octahydro-1-azocinyl)-ethyl]-guanidine (C. 5864-Su, guanethidine), administered prophylactically. On the other hand, only C. 5864-Su and reserpine, but not Apresoline, afforded protection against organic peroxide intoxication. (auth)

**10318**
MIGRATION OF THE RADIOACTIVITY IN THE SUPERIOR CERVICAL GANGLION AFTER INJECTION OF METHIONINE-$S^{35}$. J. Verne and B. Droz (Faculté de médecine, Paris). Experientia 16, 77-8(1960) (In French)

A migration of radio-activity is shown in the post-ganglionic nerves of the sympathetic ganglion, if an interval is allowed to elapse between the injection of Methionine $^{35}$S and sacrifice. This process suggests a migration of proteins elaborated by the neurons. (auth)

**10319**
RADIATION AND LIFE IN SPACE. Cornelius A. Tobias (Univ. of California, Berkeley). Federation Proc. 18, 1242-9(1959) Dec.

Information and conjectures concerning conditions in space are summarized. The probability of life on other planets is considered, with emphasis on the effects of radiation on biological systems. Based on present knowledge, it is postulated that when man visits other planets of the solar system he may be confronted with primordial conditions on some planets, strange forms of life on others, and evidence of ancient life which has become extinct on others. It is pointed out that much may be learned in earthbound laboratories concerning the role of penetrating and solar electromagnetic radiation in the generation of biological materials, the mutation and evolution of the species, and the relative role of radiation as compared to chemical environment and temperature in evolution. (C.H.)

**10320**
PRESERVATION OF HAEMATOPOIETIC TISSUES FOR THE THERAPY OF RADIATION DISEASE AND AN INDIRECT TEST OF THEIR VIABILITY. Alena Lengerová and J. Abraham (Czechoslovak Academy of Sciences, Prague). Folia Biol. (Prague) 6, 16-20(1960) (In English)

The freezing and thawing procedures suitable for glycerolized adult bone marrow cells also proved to be suitable for the preservation of mouse embryonic liver cells in a viable state, for the therapy of radiation disease. A simple device was described to reach a freezing rate variable at will according to the requirements of the cells to be frozen with regard to their maximal survival rate. The prolongation of incubation with glycerol affects the cell viability favorably, as judged by vital staining. The ability of adult spleen cells to induce splenomegaly in newborn mice was found to be a good test of different modifications of the freezing and thawing scheme and of their effect on the reproductive capacity in vivo of the cells from hematopoietic tissues. (auth)

**10321**

THE VALUE OF RADIOIODINE TESTS IN THE DIAGNOSIS OF HYPERTHYROIDISM. Ali Al-Hindawi (Republic Hospital, Baghdad). J. Fac. Med., Baghdad Iraq. 2, 1-7(1960) Jan.

The value of radioiodine in the diagnosis of hyperthyroidism was assessed by comparing the 2-hr neck/thigh ratio test with the 48-hr plasma protein bound $I^{131}$ (PBI-131). Two-hundred sixty-four patients were studied, 95 thyrotoxic, 124 non-toxic, and 45 euthyroid. The 48-hr PBI-131 test is a very reliable radioiodine test in separating toxic from non-toxic goiter. No distinction could be made between these 2 groups of patients by the use of the neck/thigh ratio test. (auth)

**10322**

ARTIFICIAL RADIOISOTOPES IN THE TREATMENT OF CHRONIC LEUKAEMIA. Saad Hasan (Republic Hospital, Baghdad). J. Fac. Med. Baghdad, Iraq. (N.S.) 2, 8-15(1960) Jan.

Results are reported from the use of colloidal gold-198 and phosphorus-32 in the treatment of chronic lymphatic leukemia. (C.H.)

**10323**

THE BINDING OF MERCURY BY THE YEAST CELL IN RELATION TO CHANGES IN PERMEABILITY. Hermann Passow and Aser Rothstein (Univ. of Rochester, N. Y.). J. Gen. Physiol. 43, 621-33(1960) Jan.

Yeast cells exposed to mercuric chloride suffer irreversible damage to the membrane, resulting in a loss of potassium and cellular anions to the medium. The maximal loss of $K^+$, but not the time course of $K^+$ loss is related to the mercury concentration, the relationship following a normal curve on a graph of log-concentration versus effect. It is concluded that the response is all or none for individual cells, and that with increasing concentrations of metal, the threshold is exceeded in an increasing proportion of the cells. Parallel studies of the binding of mercury by the cells indicate two distinct phases, only one of which is associated with the physiological response. The binding process is relatively slow but reaches an equilibrium state. Desorption is markedly dependent on temperature. No simple stoichiometric relationship exists between the binding of mercury and the physiological response ($K^+$ loss). (auth)

**10324**

THE SIGNIFICANCE OF RADIOISOTOPES IN AGRICULTURAL RESEARCH. Adalbert Süss (Bayerische Landesanstalt für Pflazenbau und Pflanzenschutz, Munich). Kerntechnik 2, 47-52(1960) Feb. (In German)

The brief survey given of the application of radioisotopes and radioactive beams to agricultural research represents only a fraction of the numerous completed and planned investigations with these new methods. It is shown that the application of radioactive indicators, in their possibilities and results, represents a still unrealized possibility of expansion of agricultural science. The results obtained yield significant suggestions for the solution of problems in ground fertility, plant nutriment, and conservation. Isotope methods do not make older methods useless, but complement them by their numerous applications, by the degree of resolution, and speed of measurement. (tr-auth)

**10325**

THE DOSIMETRY OF IODINE-124. J. L. Haybittle (Addenbrooke's Hospital, Cambridge, Eng.). Phys. in Med. Biol. 4, 280-9(1960) Jan.

Ionization measurements are reported on the $\beta$- and $\gamma$-ray emission from iodine-124. The ratio of the $\gamma$-ray dose in r/g of solution at 1 cm to the $\beta$-ray dose in rads at the center of a large volume of the same solution was found to be 0.0200 ± 0.0016 compared with values deduced from published decay schemes which range from 0.011 to 0.017. By estimating particle disintegration rate from counting measurements, a value of 8.1 ± 1.4 was deduced for the k factor of iodine-124. The clinical implications of these results are briefly discussed, and the discrepancies between published decay schemes are considered. (auth)

**10326**

INVESTIGATIONS OF NATURAL ENVIRONMENTAL RADIATION. A Profile of External Dose Rates, Cosmic and Terrestrial, Has Been Obtained with Ionization Chambers. Leonard R. Solon, Wayne M. Lowder, and Arthur Shambon (U. S. Atomic Energy Commission, New York), and Hanson Blatz (Dept. of Health, New York). Science 131, 903-6 (1960) Mar. 25.

Data are tabulated on outdoor environmental radiation measurements in various parts of the United States in 1958 and 1959. Data are compared with measurements made in 1957 and with measurements in Western Europe. (C.H.)

**10327**

POST-BOMB RISE IN RADIOCARBON ACTIVITY IN DENMARK. Henrik Tauber (National Museum, Copenhagen). Science 131, 921-2(1960) Mar. 25.

During the summers of 1958 and 1959 the increase in concentration of bomb-produced radiocarbon in Denmark was several percent higher than the average increase for the hemisphere. This additional increase is probably a carbon-14 equivalent to the spring peaks in a strontium-90 fallout in the North Temperate Zone in the same years, and suggests latitudinal variations in carbon-14 contamination. (auth)

## Biochemistry, Nutrition, and Toxicology

**10328** TID-7585(p.135-7)

Army Medical Research and Nutrition Lab., Denver.

A PROGRAM FOR THE EVALUATION OF THE POSSIBLE TOXICITY OF IRRADIATED FOODS. Irvin C. Plough. 3p.

A program of study for the evaluation of the wholesomeness of irradiated foods is discussed. Results are reported from animal and human feeding studies. (C.H.)

**10329** TID-7585(p.138-52)

Army Medical Research and Nutrition Lab., Denver.

THE EFFECTS OF IONIZING RADIATIONS ON THE NUTRITIVE VALUE OF FOODS. Merrill S. Read. 15p.

From the data accumulated to date, it is apparent that radiation treatment, even when combined with post-irradiation storage and cooking, has very little effect upon the macronutrients. The few differences in biological value, digestibility or energy content observed in individual irradiated foods are not sufficient to influence the nutritional value of mixed diets. The situation with the vitamins is not so clearcut, however. Apparently, the fat-soluble vitamins are quite easily destroyed by ionizing radiations. Nevertheless, the significance to human beings of the destruction or impaired metabolism of vitamins E and K is not easily evaluated. Among the water-soluble vitamins, the most radiation-sensitive are thiamine, pyridoxine, and pantothenic acid. At sterilization doses, the destruction parallels or is less than that caused by cooking. Nevertheless, the vitamin losses are not completely overcome by consumption of a mixed diet of irradiated foods. Therefore, the use of such diets would probably require some form of vitamin supplementation, much as is presently practiced in present day packaged military rations. The use of a mixed diet composed of both irradiated and raw nonirradiated food items would undoubtedly overcome this problem. (auth)

**10330** TID-7585(p.153-4)
Chicago. Univ.
INDUCED RADIOACTIVITY IN FOOD PRESERVED BY IONIZING RADIATIONS. John H. Rust. 2p.

It is pointed out that it is the responsibility of the toxicologists to determine whether or not the degradation products or the possibly radioactivated elements are health problems that are significant. Their decision cannot be accomplished by theoretical considerations alone but must be done whenever possible by biological assessment. Until they complete their task the use of irradiated foods by man must be held in abeyance. Research must be continued in both its basic and technical aspects while the important toxicological decision is being developed. The hope for success is great. (auth)

## Fallout and Radiation Ecology

**10331** AERE-R-3181
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE DIRECT UPTAKE OF FISSION PRODUCTS ON RYEGRASS. A. Morgan. Dec. 1959. 11p. (BIS)

Ryegrass growing on trays of vermiculite containing added nutrients was exposed to fall-out for 30 days. After this time the ryegrass was harvested from each tray and analyzed for various fission products ($Sr^{89}$, $Sr^{90}$, $Zr^{95}$, $Cs^{137}$, and $Ce^{144}$). The deposition of these fission products was calculated from the analysis of rain-water collected over the same period. The results enabled the amounts of each isotope taken up directly on the ryegrass to be calculated. Direct uptake was in the order $Ce^{144} > Zr^{95} > Sr^{90} > Cs^{137}$. The results indicate that grass will contain most, if not all, the fission products present in fall-out. The dose to the intestinal mucosa of the cow due to ingestion of observed levels of fission products on grass is shown to be negligible compared with that which has been found to produce pathological effects. However, the results draw attention to the need for considering direct uptake in the event of an accident involving the release of radioactivity. (auth)

**10332** TID-7578(p.105-11)
Tennessee. Univ., Memphis.
ABSORPTION AND RETENTION OF IODINE, REVEALED BY ISOTOPE DILUTION AND RELATED TO RADIOIODINE FALLOUT. L. Van Middlesworth. 7p.

Quantitative data are presented on the ingestion of iodine-131 from fall-out by grazing animals in widely separated parts of the world. An isotope dilution method is described for the measurement of iodine balance. Results in experimental rats are discussed. (C.H.)

**10333**
INCREASES IN THE LOCAL GAMMA-RAY BACKGROUND DUE TO NUCLEAR BOMB FALL-OUT. J. Vennart (Radiological Protection Service, Belmont, Sutton, Eng.). Nature 185, 722-4(1960) Mar. 12.

Results of measurements indicated a steady increase in gamma-ray background at Belmont, Sutton, Surrey, between 1956 and 1959, at which time the maximum had doubled. Since April 1959 there has been a spectacular fall, presumably due to the cessation of nuclear testing, until the gamma-ray background out-of-doors is barely significantly different from that measured in 1956. Measurements made within buildings varied considerably with the shielding effect of the walls but averaged about 50% of that reported out-of-doors. The magnitude of this increase in relation to man's previous radiation history is discussed. (C.H.)

**10334**
DEPOSITION OF IODINE-131 IN NORTHERN ENGLAND IN OCTOBER 1957. A. C. Chamberlain (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Quart. J. Roy. Meteorol. Soc. 85, 350-61(1959) Oct.

Isopleths of the deposition of $I^{131}$ in Northern England in October 1957 (result of Windscale accident) are given. The methods of measuring the deposition of activity and the mechanisms of deposition are discussed. (C.J.G.)

**10335**
THE TRAVEL AND DIFFUSION OF THE RADIOACTIVE MATERIAL EMITTED DURING THE WINDSCALE ACCIDENT. J. Crabtree (Air Ministry, London). Quart. J. Roy. Meteorol. Soc. 85, 362-70(1959) Oct.

The radioactive cloud formed over Northern England as a result of the Windscale accident was studied. Activity observations and meteorological data, including trajectory analysis, are presented. It is estimated that about 22,000 curies of $I^{131}$ were released to the atmosphere during the accident. (C.J.G.)

**10336**
BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY. NUMBER 17 FOR APRIL-JUNE, 1959. Tokyo, The Japan Meteorological Agency, 1959. 93p. (In English and Japanese)

Data are tabulated on the radioactivity in samples of air and rain water collected at various stations throughout Japan during April, May, and June 1959. (C.H.)

**10337**
BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY. NUMBER 18 FOR JULY-SEPTEMBER, 1959. Tokyo, The Japan Meteorological Agency, 1960. 89p. (In English and Japanese)

Data are tabulated on the radioactivity in samples of air and rain water collected at various stations throughout Japan during July, August, and September 1959. (C.H.)

## Radiation Effects on Living Tissues

**10338** AD-213640
Texas Woman's Univ., Denton.
I. BONE DENSITY MEASUREMENTS IN THE STUDY OF HEALING OF SIMULATED FRACTURES IN THE ALBINO RAT IN A CONSTANT RADIATION FIELD. II. SKELETAL STATUS OF THE ALBINO RAT AT VARIED PROTEIN LEVELS IN A CONSTANT RADIATION FIELD. Progress Report [for] June 1958—March 1959. Pauline Beery Mack, George P. Vose, and Ralph E. Pyke. Mar. 31, 1959. 73p. Contract DA-49-007-MD-956.

Progress is reported in studies of bone density during healing of simulated bone fractures in rats in a constant radiation field and the skeletal response of rats in a constant radiation field to varied dietary protein levels. (C.H.)

**10339** ORO-258
Florida. Univ., Gainesville. Cancer Research Lab.
EFFECT OF RADIATION ON THE UPTAKE OF $S^{35}$-

LABELED SULFONAMIDE. Final Report. Francis E. Ray. Mar. 15, 1960. 9p. Contract AT(40-1)-2097. OTS.

Progress is reported in studies on the distribution of radioactivity in normal and tumor-bearing mice, rats, and hamsters following intravenous injection of fluorene-2,7-di(sulfonamido-2-naphthalene) labeled with sulfur-35. It was suggested that if the chemical acts as a general stress phenomenon, the livers and spleens might react similarly to those in irradiated animals. The same effects were not observed. (C.H.)

**10340** TID-7578(p.157-62)
Oak Ridge National Lab., Tenn.
EFFECTS OF RADIATION ON THE GONADS OF MICE. E. F. Oakberg. 6p.

Results are summarized from a series of studies on the effects of radiation on the gonads of mice. Newer concepts of gametogenesis and the response of both males and females are discussed. Applications of results to other species are considered. (C.H.)

**10341** TID-7578(p.163-71)
Argonne National Lab., Lemont, Ill.
SPECTRAL POTENTIATION OF X-RAY INDUCED CHROMOSOMAL ABERRATIONS. Solon A. Gordon. 9p.

Morphological phenomena in plants controlled by the longer wavelengths of visible light, photoperiodism, photomorphogenesis, and other photoperiodic phenomena are discussed. Data are presented from recent studies on the spectral potentiation of x-ray-induced chromosomal aberrations in plants. (C.H.)

**10342** TID-7578(p.283-7)
Oak Ridge National Lab., Tenn.
THERAPY FOR RADIATION DAMAGE. G. E. Cosgrove. 5p.

Acute radiation injury may be greatly lessened by the use of radioprotective chemicals and bone marrow. Combinations of these procedures may allow doubling or tripling of the $LD_{100}$/30 days. The methods of protection appear also to alter the incidence of late radiation effects, including leukemia. Data are tabulated. (auth)

**10343** TID-7585(p.103-11)
Michigan. Univ., Ann Arbor.
THE COMPLEMENTARY EFFECTS OF THERMAL ENERGY AND IONIZING ENERGY ON MICROORGANISMS. Lloyd L. Kempe. 9p.

Applications of large sources of ionizing radiations for the commercial sterilization of foods are discussed. Theories of reaction mechanisms involved in the sensitization of microorganisms to heat by previous exposure to ultraviolet or ionizing radiations or visible light are discussed. Possible applications of combined thermal and ionizing radiations for the commercial sterilization of foods are discussed. (C.H.)

**10344** AEC-tr-4017
ON REACTIONS OF PHYCOMYCES BLAKESLEEANUS BY X-RAY AND γ-IRRADIATION. Arne Forssberg. Translated for (Oak Ridge National Lab.) from Acta Radiol. 22, 252-9(1941). 20p. (Includes original, 8p.). JCL.

The x-ray reaction of the monocellular fungus Phycomyces Blakesleeanus is briefly described by means of the citation of a few examples. Special attention is drawn to the extraordinary sensitivity of this organism, which reacts to doses of approximately 0.001 r. (auth)

**10345**
IN VITRO LEUCINE INCORPORATION INTO PROTEIN OF NORMAL AND X-IRRADIATED RABBIT BONE MARROW CELLS. Edwin M. Uyeki, Harvey Key, and Paul R. Salerno (Western Reserve Univ. School of Medicine, Cleveland). Am. J. Physiol. 198, 652-4(1960) Mar.

When compared with nonirradiated controls, the isolated bone marrow cells of x-irradiated rabbits showed a decrease in the in vitro uptake of labeled leucine into proteins 1 and 2 days after exposure to 400 r and 800 r. A similar magnitude of inhibition of leucine incorporation was observed in hemibody x-irradiated rabbits in which the marrow cells from the irradiated femur were compared with that from the nonirradiated side. The decreased uptake of leucine into protein after radiation may be due to an interruption in the supply of young forms during the postirradiation period, and hence, the decreased uptake of amino acids into proteins may be characteristic of the mature cells of the surviving cellular elements. (auth)

**10346**
FAILURE OF AET TO PROTECT AGAINST TESTES INJURY IN THE X-IRRADIATED RAT. B. H. Ershoff and V. Brat (Western Biological Labs., Culver City, Calif.). Am. J. Physiol. 198, 655-6(1960) Mar.

Intraperitoneal administration of AET at a level of 300 mg/kg body weight prevented death, but not testicular injury, in rats exposed to a single lethal dose of total-body x irradiation. (auth)

**10347**
STUDIES ON THE INDUCTION OF BONE AND SOFT TISSUE TUMOURS IN RATS BY GAMMA IRRADIATION AND THE EFFECT OF GROWTH HORMONE AND THYROXINE. D. B. Cater, R. Baserga, and H. Lisco (Univ. of Cambridge, Eng.; Northwestern Univ., Chicago; and Argonne National Lab., Lemont, Ill.). Brit. J. Cancer 13, 214-27(1959) June.

A single dose of 3000 roentgen of gamma irradiation from a iridium-192 teletherapy source applied to both knee joints of growing female rats induced osteosarcomata in 34 out of 116 rats. Fifty rats developed sarcomata of soft tissues, 10 cancer of the skin, and 12 had mammary cancers. Eighty days after irradiation, ten-week courses of growth hormone, thyroxine, growth hormone followed by thyroxine, and saline were given to study the effect of hormone treatment on the incidence and induction period of radiation-induced bone sarcomata. Twelve out of 30 growth-hormone-treated rats developed bone sarcomata compared with 7 out of 31 in the saline injected group. Thyroxine treatment significantly reduced the mean latent period of radiation-induced osteosarcomata. The incidence of other types of malignant tumors was not affected by the hormone treatments. (auth)

**10348**
THE INFLUENCE OF A LOCAL ASPHYXIA OF THE MARROW ON THE COURSE OF THE RADIATION DISEASE. P. G. Zherebchenko, I. G. Krasnykh, N. P. Lebkova, and S. P. Iarmonenko. Doklady Akad. Nauk S.S.S.R. 129, 1427-9(1959) Dec. 21. (In Russian)

Experiments were carried out with 263 mature white rats and 503 white mice of both sexes exposed to whole-body irradiations of 700, 750, and 800 r at 49 and 39 r per minute, respectively. One or two of the extremities of each animal were bound before exposure and unbound immediately following the exposure. The effects of the asphyxia were judged by the survival factor, time span, dynamics of degenerative alterations in the cells, mitotic index in the bone marrow, and morphological blood composition. The data obtained showed favorable effects of asphyxia on the course of irradiation injury. Twelve days after exposure to 700 to 750 r, 40 to 80% of the mice with bound extremities survived while the control group perished after 8 to 10 days. After 30 days only 10 to 15% survived. Similar data were taken on the rats. The results showed no appreciable difference in survival of animals with one or both extremities bound. (R.V.J.)

**10349**

POST-IRRADIATION CHANGES IN THE LIVER CELL PROTOPLASM. M. Šilha (Czechoslovak Academy of Sciences, Prague). Folia Biol. (Prague) 6, 61-4(1960). (In English)

Results are presented from a series of studies on the role of cytoplasmic structures in radiation injury. Measurements were made of proteolytic activity and the amount of phosphorus released during incubation of homogenates from liver irradiated in vitro. (C.H.)

**10350**

EFFECTS OF IONIZING RADIATION ON GELATIN AND THE ROLE OF VARIOUS RADIOPROTECTIVE AGENTS. A. Bolaffi, J. F. Mezzino, J. R. Lowry, and R. R. Baldwin (General Foods Research Center, Tarrytown, N. Y.). Food Technol. 13, 624-8(1959).

The effects of ionizing radiation with doses of $2 \times 10^6$, $4 \times 10^6$, and $6 \times 10^6$ rad in dry gelatin have been investigated. Irradiation of dry gelatin decreased the bloom-gel strength and viscosity. The presence of $N_2$ and low moisture during the irradiation did not minimize this radiation damage. The heat emitted by radiation had no deleterious effect on the physical properties of gelatin. Several reducing components inhibited the changes in gel strength and viscosity. A few of the mechanisms which may be responsible for this protection are discussed. (auth)

**10351**

ANTIOXIDANTS IN IRRADIATED COOKED PORK. Basil G. Tarladgis, Margaret Tims Younathan, and Betty M. Watts (Florida State Univ., Tallahassee). Food Technol. 13, 635-9(1959).

The effect of several antioxidants and copper chelating compounds, with or without sodium ascorbate, were investigated in irradiated cooked pork. Statistical evaluation of taste panel results and thiobarbituric acid tests for tissue rancidity showed that the rancid odor is a substantial component of the off odor in irradiated, unprotected samples. Rancidity was eliminated from the irradiated samples treated with antioxidants, bringing about a significant improvement in odor ratings. Antioxidants effective either alone or in combination with sodium ascorbate in retarding rancidity in the irradiated samples included polyphosphates, green tea extracts, trihydroxybutyrophenone, and tomato soup. Yeast sodium nucleate and adenosine triphosphate had some antioxidant effect, especially in combination with sodium ascorbate, but contributed an off odor similar to that of the irradiation off odor. (auth)

**10352**

SUPPRESSION OF THE OXIDATIVE PHOSPHORYLATION AFTER IN VITRO IRRADIATION OF ISOLATED MITOCHONDRIA IN DEPENDENCE ON THE DOSE AND CONCENTRATION. Hedi Fritz-Niggli and Gérard Bührer (Kantonsspitals, Zurich). Fortschr. Gebiete Röntgenstrahlen u. Nuklearmed. 92, 343-7(1960) Mar. (In German)

Irradiation of isolated mitochondria derived from rat livers and placed in an isotonic mannitol solution interferes with oxidative phosphorylation with $\alpha$-ketoglutarate, $\beta$-oxybutyrate, or succinate serving as hydrogen donors. The degree of interference depends on the dose. The degree of interference depends on the concentration of the irradiated suspension of mitochondria, increasing with decreasing concentration of the suspension. A possible role of vitamin K in the mechanism of irradiation induced interference of oxidative phosphorylation is discussed. (auth)

**10353**

SERIAL TRANSFER OF DONOR MARROW IN RADIATION MOUSE CHIMAERAS. P. C. Koller and Shiela M. A. Doak (Royal Cancer Hospital, London). Intern. J. Radiation Biol. 2, 1-7(1960) Jan.

By studying the immunological behavior of 50-day-old homologous chimeras, it has been established that some alteration has occurred in the donor marrow as a result of its persistence in the irradiated host. In an attempt to understand the nature of this alteration, bone marrow from 50-day-old homologous chimeras was serially passaged in new hosts of both host and donor strains, previously irradiated with an x ray dose of $LD_{99}$. The efficiency of the transferred marrow in protecting the secondary and tertiary hosts is compared, and the results are discussed in relation to tolerance, reversion, and changes in antigenicity. (auth)

**10354**

CHROMOSOME ABERRATIONS FOLLOWING IRRADIATION WITH HIGH-ENERGY PROTONS AND THEIR SECONDARY RADIATION: A STUDY OF DOSE DISTRIBUTION AND BIOLOGICAL EFFICIENCY USING ROOT-TIPS OF VICIA FABA AND ALLIUM CEPA. Börje Larsson and Bengt A. Kihlman (Univ. of Uppsala). Intern. J. Radiation Biol. 2, 8-19(1960) Jan.

Some radiological properties of a 185 Mev proton beam were studied with root-tips of bean and onion seedlings. The relationship between dose and number of abnormal metaphases was investigated at different depths of penetration in lucite. The effect, found in the final part of the range of penetration, was higher than expected when the physical depth-dose to surface-dose ratio is considered. The difference is partly attributed to a variation of the relative biological efficiency. The enhancing effect of oxygen was studied at high and low energies. It was found to be nearly constant. The relative biological efficiency of 170 Mev protons as compared with 180 kv roentgen rays for producing chromosome aberrations was found to be 0.7. The chromosome-breaking efficiencies of the secondary radiations from proton-irradiated tissue and brass were studied. The results indicate that the effects of secondary radiation may be neglected in therapeutic procedures. (auth)

**10355**

SOME EFFECTS OF HYPOTHERMIA AND HYPOXIA ON THE SENSITIVITY OF HeLa CELLS TO X-RAYS. L. Weiss (National Inst. for Medical Research, London). Intern. J. Radiation Biol. 2, 20-7(1960) Jan.

In vivo studies on the alterations in radiosensitivity produced in hypothermic mammals do not enable a distinction to be drawn between the effects of hypothermia per se and the concomitant hypoxia. The present experiments on the radiosensitivity of mammalian (HeLa) cells in vitro have permitted observations to be made on the separate effects of hypoxia and hypothermia. It is concluded that, whereas hypoxia produces a decrease in radiosensitivity, hypothermia produces no detectable change. (auth)

**10356**

THE EFFECT OF X-IRRADIATION ON THE BIOSYNTHESIS OF HAEMOGLOBIN. II. EXPERIMENTS WITH $\delta$-AMINOLEVULINIC ACID-2, 3-$C^{14}$. M. Schulman, K. I. Altman, and K. Salomon (Univ. of Rochester, N. Y.). Intern. J. Radiation Biol. 2, 28-36(1960) Jan.

A new method for the synthesis of $\delta$-aminolevulinic acid-2, 3-C$^{14}$ has been described. The incorporation of $\delta$-aminolevulinic acid-2, 3-C$^{14}$ into hemin was measured in bone-marrow homogenates from irradiated rabbits. At times between 0 and 28 days after 800 r of x radiation, the cellularity of the marrow, measured as its DNA-content, was found to have decreased. During the same period, the capacity of the homogenate to synthesize hemin from DAL also decreased. The changes observed could not be ascribed entirely to alterations in the cellularity of the marrow, and it is suggested that the synthesis of hemin per se is affected by radiation. A comparison with a similar study with glycine-2-C$^{14}$ as a precursor of hemin has revealed that the reactions by which DAL is formed from glycine and acetate are markedly inhibited on the seventh day after irradiation. (auth)

**10357**

THE EFFECT OF OXYGEN ON THE SENSITIVITY OF MAMMALIAN TUMOUR CELLS TO NEUTRONS AND X-RAYS. Shirley Hornsey, P. Howard-Flanders, and D. Moore (Hammersmith Hospital, London). Intern. J. Radiation Biol. 2, 37-44(1960) Jan.

Telophase abnormalities in Ehrlich ascites-tumor cells were observed 18 hours after the cells had been irradiated either with 1.5 Mev x rays or fast neutrons. The sensitivity of well-oxygenated tumor was greater than that of anoxic tumor by a factor of 2.5 in the case of x rays, but of only 1.3 in the case of neutrons. After neutron-irradiation the abnormalities showed an exponential relationship to dose, but after x irradiation the abnormalities increased more rapidly than the first power of the dose. When the proportion of abnormalities was 50 per cent the RBE in O$_2$ was 3.2, but in N$_2$ it was 6.5. (auth)

**10358**

THE EFFECTS OF X-IRRADIATION ON THE ANTIGENIC-COMBINING PROPERTIES OF SOME PURIFIED HUMAN-SERUM GAMMA GLOBULINS. Jane I. Morton (Norwegian Radium Hospital, Oslo). Intern. J. Radiation Biol. 2, 45-53(1960) Jan.

The irradiation in solution of purified, human-serum, gamma globulins with 140 to 280 kr of x rays resulted in molecular aggregation and in partial loss of immunological precipitating ability. The data suggest that the immunological changes are independent of the aggregation. In one of the proteins studied the immunological changes showed a pronounced delayed effect. (auth)

**10359**

THE EFFECTS OF $\gamma$-RAYS ON FECUNDITY AND MUTAGENESIS IN OREGON-R MALES OF DROSOPHILA. Philip T. Ives (Amherst Coll., Mass.). Intern. J. Radiation Biol. 2, 54-67(1960) Jan.

Oregon-R males were tested in day-by-day sperm samples for dominant visible and hemizygous sex-linked mutations, fecundity (number of offspring produced), and crossing-over after exposure to cobalt-60 $\gamma$ in the 100 r to 10 kr range. Tests totalled 42,184 X-chromosomes and 210,111 flies. Mutations were most frequent after irradiation during meiosis and spermiogenesis in low doses. Only sperm and gonial cells subsequently produced adult flies after exposure to 5 kr and 10 kr. After 500 r fecundity was reduced chiefly in cells in late mitosis, and in earlier and later stages with increasing doses. Reduced fecundity may not be due to the kind of mutation detected here, but both effects may combine to influence the frequency of mutations recovered, particularly from irradiated meiotic and spermiogenic cells. Males receiving 500 r might contribute more mutations to a population's gene pool than competing males after a substantially higher dose. (auth)

**10360**

CHEMICAL STEPS INVOLVED IN THE PRODUCTION OF MUTATIONS AND CHROMOSOME ABERRATIONS BY X-IRRADIATION IN DROSOPHILA. I. THE EFFECT OF POST-TREATMENT WITH CYANIDE IN RELATION TO DOSE-RATE AND OXYGEN TENSION. F. H. Sobels (Univ. of Leiden and Univ. of Utrecht, Netherlands). Intern. J. Radiation Biol. 2, 68-90(1960) Jan.

Post-treatment with hydrocyanic acid results in a significant increase of the mutation frequency in spermatids, if x radiation is delivered at a high dose-rate, but not after irradiation at a low dose-rate. A greater overall genetic effect of intensity per se has not been observed. Following radiation at both low and high intensities, post-treatment with cyanide increases the frequency of translocations in spermatids. Consequently, it has been inferred that cyanide causes a prolonged opening of chromosome breaks in spermatids and thus favors the formation of translocations. Both this finding and the fact that cyanide post-treatment also raises the mutation rate in a ring-shaped chromosome suggest that the increase in lethal frequency due to post-treatment refers not only to position-effect lethals but also to gene mutations and possibly small deletions. Data relating differential sensitivity in successive broods to oxygen tension are presented. Post-treatment with cyanide is equally effective in raising the mutation rate if high-intensity radiation is given in pure N$_2$, as in O$_2$. It is assumed that cyanide inhibits a mechanism responsible for repair of the initial radiation damage. Recovery from changes leading to lethal gene mutations then seems a metabolic process, possibly connected with respiratory energy. Injury to this repair system is independent of oxygen tension, and the reparable fraction of the initial damage after radiation in N$_2$ is equal to that after radiation in O$_2$. (auth)

**10361**

BACKGROUND RADIATION AS THE CAUSE OF FATAL CONGENITAL MALFORMATION. James Paul Wesley. Intern. J. Radiation Biol. 2, 97-112(1960) Jan.

The fraction of malformed births (deaths due to congenital malformation divided by births) is shown to vary over the earth with background radiation. Cosmic-ray energy flux is taken as the measure of background. The relation between the world-wide incidence of congenital malformation and geomagnetic latitude yields a $X^2 = 21$ ($P < 0.0001$) and is in agreement with the approximate theoretical relation. Lines of equal incidence of congenital malformation show characteristics which match variations in the earth's magnetic field or background radiation. Since the variation from 0.3 malformed births per 1000 in South-east Asia to 7.9 in Northern Ireland can be attributed to background, at least 96 per cent of all deaths due to congenital malformation can be attributed to background. The distribution of congenital malformation within the United States provides corroborative evidence. X rays have caused a 6 per cent increase in congenital malformation in the United States in the last 30 years. (auth)

**10362**

EFFECTS OF LOCAL ROENTGEN IRRADIATION ON THE RATE OF ENDOGENOUS-DEHYDROGENASE ACTIVITY IN THE EPIDERMIS AND THE CORIUM IN MICE STUDIED BY MEANS OF A TETRAZOLIUM-REDUCTION METHOD. O. H. Iversen and F. Devik (Rikshospitalet, Oslo). Intern. J. Radiation Biol. 2, 119-22(1960) Jan.

A tetrazolium-reduction method was applied to the study of the acute radiation effect on the epidermis and the corium in mouse skin. A pronounced effect is shown after 2700 r in the epidermis. (auth)

**10363**

SENSITIVITIES OF DIFFERENT BACTERIOPHAGE SPECIES TO IONIZING RADIATIONS. G. Bertani (Univ. of Southern California, Los Angeles and Los Angeles County Hospital). J. Bacteriol. 79, 387-93(1960) Mar.

The sensitivities to ionizing radiations of 13 different phage species have been measured, and compared with the information available in the literature for still other species of phage. The most sensitive (a Mycobacterium phage) is about 13 times more sensitive than the most resistant (coli-dysentery phage $\phi$X-174, S13). The most common radiosensitivity value corresponds to about $^4/_{10}$ of the radiosensitivity of the T-even phages. Lysogenic hosts may repair a fraction of the damage produced in phage by ionizing radiations. (auth)

**10364**

OBSERVATIONS ON MICE EXPOSED TO COSMIC RADIATION IN THE STRATOSPHERE. A LONGEVITY AND PATHOLOGICAL STUDY OF 85 MICE. Irwin J. Lebish, David G. Simons, Herman Yagoda, Peter Janssen, and Webb Haymaker (Armed Forces Inst. of Pathology, Washington, D. C.). Military Med. 124, 835-47(1959) Dec.

The biological effects of 24-hr exposure of primary cosmic radiation to 85 mice at 80,000 ft or above were studied. Control mice on the ground were subjected to the same conditions and both groups of animals allowed to live out their life span. The average longevity, fertility rate, mammary adenocarcinoma, lung tumors, and other neoplasms of the two groups were approximately the same. It is concluded that no definite evidence was found that a day's exposure to light and medium weight primary cosmic particles in the stratosphere produces any adverse long-term effect. (C.J.G.)

**10365**

PRESENT HEALTH OF CHILDREN GIVEN X-RAY TREATMENT TO THE ANTERIOR MEDIASTINUM IN INFANCY. Eugene A. Conti, George D. Patton, Jane E. Conti, and Louis H. Hempelmann (Pittsburgh Hospital). Radiology 74, 386-91(1960) Mar.

A survey was made of 1,564 children in Pittsburgh given x-ray treatments to the thymus gland as a routine between 1938 and 1946. In 224 children, the diagnoses of enlarged thymus glands was made at birth. Eighty per cent of these were treated with 200 to 450 r of 140-kvp x rays through a 4 × 4-cm port. Ninety-five per cent of the 1,340 children with thymus glands of normal size were given 150 r through a port of the same size. Between 1956 and 1958, the families of 89.6 per cent of the treated children were questioned about the medical histories of these children and of their 2,923 untreated siblings. Positive medical data were confirmed but negative data were not tested. The death records of the Pennsylvania State Department of Health were also searched, as were the leukemia records from 1954 to 1957. No cases of malignant disease were found in the treated group, although 4 cases of cancer, including 1 of leukemia would be expected to occur in a group of children of this size and age distribution. The 4 malignant tumors in the sibling group, including 1 case of leukemia, compared closely with the expected number. (auth)

**10366**

SPENT RADON SEEDS: I. LATE EFFECTS. John B. Graham, Ruth M. Graham, Luciano S. J. Sotto, and Norman A. Baily (Roswell Park Memorial Inst., Buffalo). Radiology 74, 399-402(1960) Mar.

Case histories are reviewed which tend to support the view that spent radon seeds have some biologic activity, either destructive or carcinogenic. The history of medical usage of ionizing radiation is replete with practices that were at first regarded as innocuous but subsequently proved hazardous. It is possible that spent radon seeds may be another example of a practice that is not entirely free from danger. Certainly they would bear more thorough investigation. (auth)

**10367**

SPENT RADON SEEDS: II. RADIATION FROM SPENT RADON SEEDS. H. E. Johns and L. D. Skarsgard (Univ. of Toronto). Radiology 74; 403-6(1960) Mar.

Measurements were made of the radiation dose from spent radon seed from ten to 25 years after use. (C.H.)

**10368**

THE CONSEQUENCES OF THE CONTINUOUS INGESTION OF Sr$^{90}$ BY MICE. Miriam P. Finkel, Patricia J. Bergstrand, and Birute O. Biskis (Argonne National Lab., Lemont, Ill.). Radiology 74, 458-67(1960) Mar.

Two groups of mice are being maintained on food containing Sr$^{90}$. The first was placed on the special diet at 110 to 250 days of age, and this group produced the second, which has been exposed to Sr$^{90}$ since conception. Levels of dietary Sr$^{90}$ as high as 10 μc/gm Ca did not adversely affect conception, parturition, or lactation. The median survival time of the dams maintained on this level of Sr$^{90}$ for 525 days, however, was reduced by about 17 per cent. Dams maintained on 5 μc Sr$^{90}$/gm Ca or less did not differ substantially from the control mice in survival time or in disease incidence during these 525 days. The median life span of mice exposed to 10 μc Sr$^{90}$/gm Ca since conception was reduced by about 41 per cent. A decrease in survival time was also apparent among the mice reared on 5.0, 2.5, and 1.0 μc Sr$^{90}$/gm Ca. Tumors that can be attributed to radiation have appeared only among those mice maintained throughout life on 10 μc Sr$^{90}$/gm Ca. Besides an increase over the normal incidence of tumors of the blood-forming tissues, there have been epidermoid carcinomas of the oral cavity, osteolytic tumors of the skeleton, and osteogenic sarcomas. The osteogenic sarcomas appeared much later and in much smaller number than had been expected on the basis of previous experience with mice that had been injected with Sr$^{90}$. Since the major difference between a single injection and continuous ingestion concerns the dose rate, it appears that the amount of radiation absorbed per unit time is an important factor in the neoplastic process. In addition, the delay in the appearance of osteogenic sarcomas until the mice were approximately 450 days old suggests that very young mice are not necessarily more sensitive to a radiocarcinogenic stimulus than adult mice. (auth)

**10369**

SUPPRESSION OF RADIATION-INDUCED TUMORIZATION IN FERN PROTHALLI. Carl R. Partanen (Children's Hospital, Boston and Children's Cancer Research Foundation, Boston). Science 131, 926-7(1960) Mar. 25.

By quantitative techniques it has been shown that the expected tumor frequency after x irradiation of spores of the fern *Pteridium aquilinum* can be reduced by the addition of casein hydrolyzate or amino acids to the medium upon which the spores are germinated and grown into either prothalli or tumors. (auth)

# CHEMISTRY

## General and Miscellaneous

**10370** AD-211742
Uppsala Univ.
THE TWO-ELECTRON HOMOPOLAR CHEMICAL BOND; HYDROGEN. Technical Note No. 17. Harrison Shull. Sept. 15, 1958. 40p. Contract AF61(514)-1200.

The correlation energy of the hydrogen molecule is considered as related to the He atom and to the infinitely separated atoms, and it is shown that one can obtain a consistent qualitative picture of the electron-electron interaction in the molecular bond in this way. Previous approximate wave functions for hydrogen are analyzed quantitatively into approximate natural spin orbital functions with particular attention to the corresponding occupation numbers. The analysis demonstrates the similarity of all such trial wave functions, the largely molecular orbital nature of the wave function, the similarity between the molecular orbital and valence bond functions, and the necessity for allowing for angular correlation of the electrons. The analysis shows that the concepts of covalent and ionic character, at least as applied to the two-electron homopolar chemical bond, have no real significance and should be abandoned. (auth)

**10371** AECU-4715
Massachusetts Inst. of Tech., Cambridge. Lab. for Insulation Research.
PROGRESS REPORT NO. XXVI. Jan. 1960. 73p. Contracts Nonr-1841(10); Nonr-1841(50); AT(30-1)-1937; AF19(604)-5482; and AF33(616)-5920. OTS.

Research is reported on insulation materials. Investigations on oxides included: formation of $Fe^{4+}$ in $LaFeO_3$–$SrFeO_3$, crystal structure of $V_2O_3$ and $Cr_2O_3$, $V_2O_3$–$Cr_2O_3$, $V_2O_3$–$Al_2O_3$, $Al_2O_3$–$Cr_2O_3$, high-temperature conductivity of iron oxides, pressure dependence of Néel temperature in CoO and NiO, Y–Fe garnet preparation, transition metal hydroxides, effect of Fe substitution for Ti in $SrFeO_3$–$SrTiO_3$, effect of Bi in $BaTiO_3$, $Al_2O_3$ and $TiO_2$ films, electric breakdown of $TiO_2$ and titanates, paramagnetic resonance in rutile, optical excitation of paramagnetic ions, paramagnetic garnets, and theory of spin-lattice relaxation. Studies on alkali halides and alkaline earth halides included: color centers in Cs halide single crystals and alkaline earth fluorides, effect of mono- and trivalent cations or color centers in $CaF_2$, purification of alkali halides by zone melting, electron nuclear double resonance in LiF, temperature and thickness dependence of electric strength of alkali halides, interaction of polarizable KCl crystal with a valence-band hole, and breakdown of alkali halides at low temperatures. Investigations are also reported on: preparation of solid solutions of ammonium, aluminum, chromium, alum, lattice parameters of HgTe–CdTe, and optical and electrical properties of HgTe. Progress in instrumentation and techniques is also reported. (For preceding period see AECU-4306.) (T.R.H.)

**10372** AECU-4720
Michigan State Univ., East Lansing.
PHYSICAL PROPERTIES OF THE HALOGEN FLUORIDES AND THEIR SOLUTIONS. Max T. Rogers. [1959?]. 5p. OTS.

Physical properties of halogen fluorides were determined. The resulting data are interpreted in terms of self-ionization in the pure liquids and ionization in solution, association in the pure liquids, and electron donor-acceptor properties of the molecules. (J.R.D.)

**10373** AECU-4726
Bureau of Mines. Boulder City Metallurgy Research Lab., Nev. and Bureau of Mines. Reno Metallurgical Research Center, Nev.
ELECTROCHEMICAL STUDIES OF HAFNIUM, ZIRCONIUM AND YTTRIUM. Quarterly Progress Report No. 9 [for] October 1, 1959 to December 31, 1959. 6p. PURE METALS PROJECT. Contract AT(11-1)-475.

Efforts to recover residues from the deep bath cell consisting of finely divided pure hafnium metal containing 2.5% oxygen, 0.29% nitrogen, and other impurities are described. A total of 5500 g was recovered representing about 65% recovery from the total anode material used. The recovered metal was then used as anode material in a 12-inch diameter cell to determine if a KCl + NaCl + $K_2ZrF_6$ electrolyte, containing 1.5% soluble zirconium, could be converted to a KCl + NaCl + $K_2HfF_6$ electrolyte by plating out the zirconium and replacing it with hafnium. The procedure was shown to be successful. Other aspects of procedure and earlier development are discussed. Progress in the electrorefining of yttrium is also reviewed and recommendations for further work are given. (J.R.D.)

**10374** AECU-4738
South Carolina. Univ., Columbia.
DEPARTMENT OF CHEMICAL ENGINEERING [FINAL REPORT]. PART II. HEAT CAPACITY AND THERMODYNAMIC PROPERTIES OF SATURATED DEUTERIUM OXIDE. B. L. Baker. Sept. 15, 1959. 50p. Contract AT(38-1)-118. OTS.

Part I issued as AECU-4043.

The heat capacity of saturated deuterium oxide was determined at 30 to 200°C by comparison methods using ordinary water as a standard. The work was divided into two temperature ranges, 30 to 80°C, and 100 to 200°C. Somewhat different experimental techniques were employed for each range because of the vapor pressures of deuterium oxide at these temperatures. Extrapolation of the data at 80 to 100°C agreed almost precisely. The results at 30 to 200°C can be expressed by the equation: $c_p = 1.00619 + 9.11306 \times 10^{-5}t - 1.56282 \times 10^{-6}t^2 + 3.94195 \times 10^{-9}t^3$ BTU/Lb-°F where $c_p$ = specific heat capacity at saturation pressures and t = °F at 86 to 392. One standard deviation is 0.0072 BTU/Lb-°F. Specific enthalpy and entropy values of saturated liquid and vapor deuterium oxide were calculated at 3.81 to 200°C. They were estimated above 200°C to the critical temperature and pressure by using the law of corresponding states. Values of specific enthalpy and entropy were based on zero values at the triple point. Saturation vapor pressures have been estimated from data selected from the literature. (For Part I see AECU-4043.) (auth)

**10375** AERE-R-3022
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
ION EXCHANGE REVIEWED AS A CONTINUOUS PROCESS. K. R. Poole. Dec. 1959. 13p. BIS.

A review was made of the potentialities of ion exchange as a continuous process and of the contacting apparatus employed. The apparatus is evaluated from both technical and economic standpoints, and design theory is outlined. (auth)

**10376** AFOSR-TN-59-1153
Purdue Univ., Lafayette, Ind.
THE THERMAL DECOMPOSITION OF PRASEODYMIUM NITRATE. F. Vratny and J. M. Honig. Nov. 1959. 30p. Contract AF18(603)-45.

The thermal decomposition of $Pr(NO_3)_3$ has been measured in the temperature range $285 \leq T \leq 485$°C. In conjunction with infrared spectra of the solid decomposition products it is postulated that the reaction proceeds via an intermediate nitrite structure. The composition of the final nonstoichiometric oxide varied with the temperature at which the reaction was allowed to proceed. Various characteristic features of this decomposition reaction are discussed. (auth)

**10377** BNL-588
Rensselaer Polytechnic Inst., Troy, N. Y.
CHEMICAL BEHAVIOR OF URANIUM AND THORIUM IN FUSED SALTS. Second Annual Report. Report No. 8 (Final). Derek L. Hill and Robert A. Osteryoung. Sept. 30, 1959. 11p. For Brookhaven National Lab. Contract AT-30-2-GEN-16, Subcontract S-348. OTS.

The chemical behavior of uranium was studied in the binary eutectic LiCl (59 mole %)$-$KCl (41 mole %) and the ternary eutectic $MgCl_2$ (50 mole %)$-$NaCl (30 mole %)$-$KCl (20 mole %) at 450°C. The U(III)$-$U(O) potential and the U(IV)$-$U(III) redox potential were measured coulometrically in $MgCl_2-NaCl-KCl$. The polarographic behavior of U(III) and U(IV) in LiCl$-$KCl was studied. The polarography and potentiometry of solutions of uranyl species prepared in both eutectics were studied. (C.J.G.)

**10378** CEA-1194
France. Commissariat à l'Énergie Atomique, Paris.
LES SELS FONDUS DANS LES RÉACTEURS NUCLEAIRES (BIBLIOGRAPHIE). (Molten salts in Nuclear Reactors (Bibliography)). J. Dirian and R. Saint-James. 1959. 33p.

A collection is presented of references dealing with the physicochemical studies of fused salts, in particular the alkali and alkali earth halides. Numerous binary, ternary and quaternary systems of these halides with those of uranium and thorium are examined, and the physical properties, density, viscosity, and vapor pressure going from the halides to the mixtures are also considered. References relating to the corrosion of materials by these salts are included and the treatment of the salts with a view to recovery after irradiation in a nuclear reactor is discussed. (auth)

**10379** CEND/2407/RS/68
Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.
OXYGEN REMOVAL FROM REACTOR WATER BY A COPPER AMMINE COMPLEX EXCHANGE RESIN. A. S. Powell and E. V. Falcone. Dec. 18, 1959. 12p. Contract DA-44-192-ENG-11.

Tests were made which show that it is feasible to use a copper amine complex exchange resin to remove oxygen from reactor water at flows of 12 gpm/$ft^3$ at 200°F and pH 6 to 8. The oxygen-removal capacity of the resin depends on packing in the column. A system design permitting insertion of a pre-regenerated column into a flow of water to be scavenged is required. Experimental runs are described. (J.R.D.)

**10380** CRER-875
Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.
THE ABSORPTION OF SOME NITROSYL RUTHENIUM COMPLEXES BY COTTON. P. J. Barry. Jan. 1960. 12p. (AECL-912). AECL.

The absorption of nitrosyl ruthenium complexes by cotton was shown to be a cation exchange process. The ruthenium compounds in solution are a complex mixture of species, cationic, anionic and neutral. In the solutions studied only the cationic species were absorbed by the cotton. (auth)

**10381** CRGP-888
Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.
AN ELECTROPLATING METHOD FOR MAKING THIN FOILS OF NICKEL 58. H. R. McCrady. Nov. 25, 1959. 5p. (AECL-943). AECL.

An electroplating method for producing nickel-58 Van de Graaff targets is described. Satisfactory contamination-free targets were produced in a sulfate plating bath from nickel metal and oxide. (auth)

**10382** FRDC/P-105
United Kingdom Atomic Energy Authority. Industrial Group. Culcheth Labs., Culcheth, Lancs, England.
THE OXIDATION OF SODIUM. A REVIEW OF PROGRESS FROM APRIL 1, 1954 TO DECEMBER 31, 1954. H. C. Cowen and H. Vickers. Apr. 15, 1955. Changed from OFFICIAL USE ONLY June 15, 1959. 9p. (RDB(C)/TN-121).

The tendency of liquid Na to ignite on being forced through a small hole was investigated. The holes ranged from 0.008 to 0.020" in diameter, and the atmospheres into which the Na was ejected included air and $N_2$, both moist and dry. With atmospheres of air, ignition was observed at all temperatures down to 120°C (the lowest used), irrespective of the moisture content of the air. No ignition was observed with atmospheres of $N_2$. (auth)

**10383** GAT-T-700
Goodyear Atomic Corp., Portsmouth, Ohio.
TWO INFRARED METHODS FOR CALCULATING ISOMER PERCENTAGES IN DICHLOROTETRAFLUOROETHANE ($C_2F_4Cl_2$). F. C. Steinbach. Nov. 9, 1959. 10p. Contract AT(33-2)-1. OTS.

Methods of measuring the isomeric contents of dichlorotetrafluoroethane are presented. Infrared methods developed at ORGDP and GAT are described and compared. (J.R.D.)

**10384** HW-56281
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
COALESCENCE IN PULSE COLUMNS. W. R. Hamilton. June 24, 1959. Decl. Feb. 4, 1960. 70p. Contract W-31-109-Eng-52. OTS.

The organic coalescing characteristics of linear polyethylene sieve plates in a mixed cartridge with stainless steel sieve plates are described in terms of a coalescence index number and evaluated under various pulse column conditions. (auth)

**10385** HW-61872
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
EVALUATION OF DEOXYGENATING ION EXCHANGE RESINS. Thomas F. Demmitt. Sept. 21, 1959. 11p. Contract AT(45-1)-1350. OTS.

The $O_2$ removal properties of Duolite S-10 and $Na_2SO_3$-regenerated Amberlite IRA-400 resins were studied with varying feedwater temperature, flow rate, and quality of influent water. The Duolite S-10 reacted faster, had a higher $O_2$ capacity, and permitted less $O_2$ leakage in operation. The Amberlite was affected by impure tap water. Neither resin was affected by feedwater temperatures between 45 and 75°F. (T.R.H.)

**10386** NAA-SR-4657
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
INFRARED SPECTRA OF BIPHENYL AND SEVERAL DEUTERATED BIPHENYLS. J. M. Scarborough. Mar. 15, 1960. 18p. Contract AT-11-1-GEN-8. OTS.

The infrared solution spectra of biphenyl, biphenyl-4,4′-$d_2$, biphenyl-2,2′,6,6′-$d_4$, biphenyl-3,3′,5,5′-$d_4$, biphenyl-2,2′,4,4′,6,6′-$d_6$, biphenyl-2,2′,3,3′,5,5′,6,6′-$d_8$, and biphenyl-$d_{10}$ are presented. All spectra were obtained on a spectrophotometer using LiF, NaCl, and KBr optics. (auth)

**10387** NAA-SR-4803
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
INVESTIGATION OF TETRALIN EXPLOSION. J. S. McDonald and J. E. Owens. Mar. 1, 1960. 64p. Contract AT-11-1-GEN-8. OTS.

An investigation was conducted to determine the cause of an explosion which occurred in apparatus used for a natural-convection heat-transfer experiment with sodium. During the course of the experiment, cooling was provided to the heat sink by circulating tetrahydronaphthalene (tetralin). At the conclusion of the work, tetralin was allowed to remain stagnant in the cooling section over a period of several months. The autoxidation of tetralin to the hydroperoxide is postulated, the explosion resulting from the rapid decomposition of this compound. The condition and circumstances initiating the decomposition are unknown. (auth)

**10388** NAA-SR-Memo-4269(Rev. 1)
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
THE HIGH TEMPERATURE CHEMICAL REACTIVITIES OF THE URANIUM CARBIDES. Louis Silverman. Aug. 19, 1959. 16p. OTS.

The reactions of UC, $UC_2$, and $U_2C_3$ with various elements and compounds were investigated. (W.L.H.)

**10389** NAA-SR-Memo-4585
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
RELATIVE ECONOMIC WORTH OF HIGH TEMPERATURE ORGANIC COOLANTS. J. E. Gingrich. Nov. 4, 1959. 14p. OTS.

An investigation was made to determine if the use of certain alternate coolants which operate at significantly higher temperatures can reduce the power costs of organic cooled and moderated reactors. Calculations are presented and a table comparing a typical organosilane with Santowax-R is included. (J.R.D.)

**10390** ORNL-2815
Oak Ridge National Lab., Tenn.
REDUCTION OF CUPRIC OXIDE BY HYDROGEN. I. FUNDAMENTAL KINETICS. W. D. Bond and W. E. Clark. Mar. 30, 1960. 27p. Contract W-7405-eng-26. OTS.

Basic studies of the kinetics of the reduction of copper oxide were made to establish the effect of the solid phase on the over-all reaction kinetics. The reaction $CuO + H_2 \rightarrow Cu + H_2O$ consisted of an induction stage, an acceleration or autocatalytic stage terminating at about 35% reduction of the oxide, and a decreasing-rate stage. The reduction rates for each stage were dependent on the nature of the initial oxide, the degree of subdivision of the oxide, and the temperature, but were independent of the mass of the oxide phase. Addition of the reaction product copper had no measurable effect on the reaction. Water vapor in concentrations of 25 mg per liter of H prevented reduction at 112°C. The inhibiting effect decreased rapidly as the temperature was increased and disappeared entirely at 190°C. Once reduction had started, water vapor had practically no effect. The acceleration and decay stages were very closely approximated by a semiempirical equation based on the initial reaction occurring on certain active nuclei followed by a rapid growth of these nuclei by a branching-chain mechanism. The reduction rate reached a maximum and subsequently decreased as considerable interference occurred among the branching nuclei. Arrhenius plots gave an activation energy of 13.5 ± 1.2 kcal for the reduction. (auth)

**10391** ORNL-2894
Oak Ridge National Lab., Tenn.
THE SOLUBILITY OF NITROGEN AND OXYGEN IN LITHIUM AND METHODS OF LITHIUM PURIFICATION. E. E. Hoffman. Mar. 17, 1960. 23p. Contract W-7405-eng-26. OTS.

Experiments were conducted to determine the solubility of N and O in Li at 250 to 450°C and to determine which of several possible purification methods is most effective in reducing the N and O content of Li. The solubility of N in Li increased from 0.04 wt.% at 250°C to 1.31 wt.% at 450°C. The solubility of O was found to be 0.010 wt.% at 250°C and increased to 0.066 wt.% at 400°C. Vacuum distillation, low-temperature filtration, cold-trapping, and gettering with active metals were investigated as possible purification methods to reduce the N and O content of Li. Of the techniques studied, gettering with active metals was found to be the most effective method of reducing the N concentration, while cold-trapping and low-temperature filtration were most effective in reducing the O concentration. (auth)

**10392** PGR-77(W)
United Kingdom Atomic Energy Authority. Production Group. Chemical Services Dept., Windscale, Sellafield, England.
THE PREPARATION AND INFRA-RED SPECTROMETRIC EXAMINATION OF SOME COMPLEX COMPOUNDS OF URANYL NITRATE HYDRATES AND ORGANIC SOLVENTS. E. Hughes, W. L. Brooks, and J. K. Foreman. Dec. 1959. 10p. BIS.

Declassified Version of IGO-TM/W-08 (IGC-ARDC/P-175).

Well defined compounds obtained by mixing oxygen-containing organic solvent with uranyl nitrate hydrates have been analysed chemically and by infra-red spectrometry. The spectra of some of them are presented and compared with the spectra of known co-ordinated complexes obtained with pyridine and uranyl nitrate. Some conclusions on the structure of these compounds are presented. (auth)

**10393** RFP-183
Dow Chemical Co. Rocky Flats Plant, Denver.
PURIFICATION OF AMERICIUM CHLORIDE SOLUTIONS BY MERCURY CATHODE ELECTROLYSIS. J. L. Holst and C. W. Barrick. Mar. 31, 1960. 9p. Contract AT(29-1)-1106. OTS.

A process has been developed for the removal of chromium, copper, iron, manganese, nickel, lead, tin, and zinc impurities from an acid aqueous solution of americium chloride using a mercury cathode cell operating at 5 to 10 amperes and 16 to 18 volts. The americium is not affected. The process may also be used to remove other impurity elements. (auth)

**10394** RISLEY-5057/1
Gt. Brit. Div. of Atomic Energy (Production), Risley, Lancs, England.
THE DISSOLUTION OF CAST URANIUM RODS IN 3N NITRIC ACID CONTAINING 0.3GM. URANIUM PER MILLILITRE. (First Interim Report). J. H. Tonkin. Jan. 19, 1949. 10p.

A small-scale experiment is described which shows that the rate of dissolution of cast uranium metal in 3N nitric acid containing 0.3 g uranium per milliliter is about

43 g/kg/hr. The average reaction seems to be represented by the equation $U + 4\,HNO_3 = UO_2(NO_3)_2 + 2H_2O + 2NO$, and reasonable consistency of solution is obtained by addition of $8\underline{N}$ nitric acid. (auth)

**10395** SCS-R-270
Gt. Brit. Springfields Works, Springfields, Lancs, England.
A MODIFIED LUNDEGARDH SPRAY CHAMBER. P. C. Palin. Apr. 2, 1951. 5p.

Operation of an apparatus for analysis of solutions by the Lundegardh flame technique was greatly facilitated by the modification of a spray chamber. Samples can be introduced and removed from the modified spray chamber without extinguishing the flame or dismantling the assembly. (auth)

**10396** TID-7571(p.202-8)
Kansas. Univ., Lawrence.
NEW METHODS FOR PRODUCTION OF RADIOISOTOPE LABELED COMPOUNDS. F. S. Rowland. 7p.

Methods are described for the preparation of compounds labeled with radioisotopes by biosynthesis by a living organism utilizing labeled precursors, by chemical synthesis from one or more simple radioactive molecules, by chemical exchange under conditions of lability for the isotope involved, and by nuclear reactions for recoil labeling. Nuclear reactions for recoil labeling are discussed in detail. (C.H.)

**10397** TID-7578(p.33-8)
Argonne National Lab., Lemont, Ill.
LABELING OF ORGANIC COMPOUNDS WITH TRITIUM. K. E. Wilzbach. 6p.

The introduction of radioactive hydrogen into organic compounds by tritium-recoil particles, by exposure to tritium gas, and by an electrical discharge in tritium is discussed. These methods provide a route to labeled compounds not previously accessible and yields products which can be used with greater confidence as tracers in some applications. Each method has a particular area of usefulness and together they promise increased use of tritium in the solution of chemical, biological, and industrial problems. (auth)

**10398** TID-7578(p.39-48)
Kansas. Univ., Lawrence.
GAS COUNTING OF TRITIUM-LABELED COMPOUNDS. F. S. Rowland, J. K. Lee, and R. Milford White. 10p.

Techniques and experiences in gas-phase proportional counting of tritium-labeled organic compounds are summarized. (C.H.)

**10399** UCRL-8972
California. Univ., Berkeley. Lawrence Radiation Lab.
NUCLEAR QUADRUPOLE RESONANCE OF SOME INORGANIC CHLORINE COMPOUNDS (thesis). Allan Harvey Reddoch. Nov. 1959. 175p. Contract [W-7405-eng-48]. OTS.

The theory of nuclear quadrupole resonance is reviewed. The various chemical interpretations of nuclear quadrupole resonance are discussed critically. A fairly simple method is outlined for determining the asymmetry parameter of the electric field gradient from the observed transition frequencies without directly solving the secular equation. The chlorine resonance in titanium tetrachloride has been reexamined. The existence of four resonances has been clearly shown, confirming Dehmelt's work but not that of Hamlen and Koski. The chlorine-35 resonance in thorium tetrachloride has been discovered. It consists of a single line at about 6 Mc. The low frequency of the resonance suggests highly ionic bonding. This interpretation differs from that based on x-ray studies but seems to be more certain. The temperature dependence of the resonance frequency does not follow Bayer's theory. Some double-bond character may account for the difference. Niobium and chlorine resonances have been discovered in niobium pentachloride. The niobium resonances are described by a single set of parameters, the coupling constant being, approximately, eqQ = 78 Mc, and the asymmetry parameter, $\eta = 0.32$. Because of the large asymmetry parameter, it was possible to observe two $\Delta M = 2$ and one $\Delta M = 3$ transitions. A single chlorine-35 resonance was found at about 13 Mc. Two more chlorine resonances would be expected on the basis of the crystal structure, but they have not been found. The frequency of the chlorine resonance suggests appreciable covalency in niobium pentachloride. (auth)

**10400** USNRDL-TR-370
Naval Radiological Defense Lab., San Francisco.
OXIDATION STATES OF $U^{237}$ AND $Np^{239}$ IN UNDERWATER BURST DEBRIS. S. C. Foti and E. C. Freiling. Sept. 24, 1959. 17p. OTS.

A procedure is described which separates the U and Np present in seawater into their various oxidation states. Application of the procedure to ultrafiltrates of surface water samples from an underwater burst and a lagoon bottom burst is described. Results are presented as a function of time and correlated with physical state distributions made on the same samples. (auth)

**10401** WADC-TN-59-258
Indiana. Univ., Bloomington.
AN EXPERIMENTAL INVESTIGATION ON THE CHEMISTRY AND INTERCONVERSION OF BORON HYDRIDES. Period [covered]: July 1, 1958 to June 30, 1959. Riley Schaeffer. July 1959. 50p. Project No. 3048. Contract AF33(616)-5827. OTS.

A method for preparing diborane by radical catalyzed reaction of trichloroborane and monosilane is described. Experimental studies of various steps in the thermal conversion of diborane to pentaborane-11 are described. Physical properties of tetraborane-8 carbonyl including vapor pressures, infrared spectrum, NMR spectrum, and mass spectrum are reported. Reaction of bridge labeled decaborane with acetonitrile released hydrogen of deuterium content corresponding closely to release of one bridge and one non-bridge proton. Reaction of bridge labeled decaborane with $CH_3MgI$ produced ~25% $CH_3D$. A new amine derivative of a borane has been obtained by treatment of $(CH_3)_3NB_3H_7$ with hydrogen chloride and diborane. (auth)

**10402** WADC-TR-59-251(Pt.II)
Du Pont de Nemours (E. I.) & Co. Eastern Lab., Gibbstown, N. J.
SYNTHESIS OF THERMALLY STABLE INORGANIC AND SEMI-INORGANIC BASE FLUIDS. PART II. [Period covered] June 1959 to January 1960. John A. Parkins. Jan. 1960. Project title: SECONDARY POWER COMPONENTS AND MATERIALS. Task title: HYDRAULIC FLUIDS. Contract AF33(616)-5843. 29p.

Continued study of antimony-stabilized phosphonitrilic chloride failed to show the structure of the antimony-stabilized phosphonitrilic chloride or the mechanism by which antimony exerts its effect. Stabilization appears to be specific to antimony. Thiocyanate, cyanate, fluoride dimethylamine, methoxy and trifluoromethyl derivatives of either regular phosphonitrilic chloride or antimony-stabilized phosphonitrilic chloride were prepared. A partially substituted trifluoromethyl derivative melted below −10°C and boiled at 508°C without polymerization.

A precipitation technique to obtain valentinite for the preparation of stiboxanes was not effective. An antimony-phosphorus oxane was prepared. (auth)

**10403** AEC-tr-3963
REFLECTION SPECTRA. Jean Lecomte (Le Compte). Translated by Ed Day and Ed Farquhar (Ames Lab.) from p.534-73, Vol. II, of "Rayonnement Infrarouge," 1949. 29p. JCL.

A study is presented of the reflection spectra of various elements and compounds. (W.L.H.)

**10404** AEC-tr-3999
THE REMOVAL OF OIL FROM BOILER FEED WATER. Johannes Körting. Translated by M. Schloo (Savannah River Lab.) from Wärme 62, 657(1939). 1p. JCL.

A method of oil removal from boiler feed water by hard sharp cornered stone, basalt, or granite is described. The oil particles remain hanging on the stone surfaces, group together, and drop from the sharp corners, subsequently floating to the top to be removed by skimming. (J.R.D.)

**10405** AEC-tr-4002
ELECTROSTATIC INDUCED DISPLACEMENT OF NUCLEAR MAGNETIC PROTON RESONANCE LINES IN DILUTE POLAR LIQUIDS. P. Diehl. Translated for Savannah River Lab. from Helv. Phys. Acta 30, 91-2 (1957). 1p. JCL.

Results of spectral examination of unlike polar liquids diluted with nonpolar liquids are presented. (J.R.D.)

**10406** AEC-tr-4006
ON THE CRYSTALLIZATION OF COLLOIDAL SALT SOLUTIONS. THE SOLUTION AND THE REPRECIPITATION OF SALTS AS A RESULT OF ITS HYDROLYTIC CLEAVING. F. Krafft. Translated by D. E. Cardamone (Savannah River Lab.) from Ber. deut. chem. Ges. 2, 1597-8(1899). 2p. JCL.

Data are presented to confirm the presence of hydrolytically cleaved fatty acid sodium salts in either dilute or concentrated aqueous solutions. A series of pure hard soaps was prepared and used to confirm an initial observation on sodium stearate that formation of concentrated crystalline or globular hard masses always occurs just below the solidification temperature of the free acid and establishes water as the chemical cleavage agent in dissolution of such salts. (J.R.D.)

**10407** AEC-tr-4008
THE REMOVAL OF OIL, BENZENE, AND RESIDUAL BENZOL FROM CONDENSATION WATER WITH ACTIVATED CARBON. M. Jaenicke. Translated by M. Schloo (Savannah River Lab.) from Chemiker-Ztg. 64, 630-2 (1932). 6p. JCL.

Results of experiments conducted to determine the efficiency of activated carbon for removal of oil from hot oil-bearing condensation water are presented. The condensation water contains about 0.8 g oil/M$^3$ after filtration through a water purification type of activated carbon. Water which contains readily boiling hydrocarbons can be purified by another type of activated carbon. (J.R.D.)

**10408** AERE-Trans-841
CALCIUM ORTHOPHOSPHATES. I. THE SOLID CALCIUM ORTHOPHOSPHATES. II. COMPLEX FORMATION IN SOLUTIONS OF CALCIUM AND PHOSPHATE IONS. Niels Bjerrum. Translated by M. H. Rand from Kgl. Danske Videnskab. Selskab., Mat. fys. Medd. 31, No. 7, 1-79(1958). 67p.

The preparation and properties of solid calcium orthophosphates are described preliminary to a solubility study. Attempts are made to calculate the extent of complex formation between Ca and PO$_4$ ions from pH measurements in very dilute solutions of Ca$_3$(PO$_4$)$_2$. (T.R.H.)

**10409**
LIQUID SCINTILLATION COUNTING OF AQUEOUS SAMPLES. Charles F. Gordon and Arthur L. Wolfe (Rohm & Haas Co., Philadelphia). Anal. Chem. 32, 574(1960) Apr.

A sample preparation method which permits liquid scintillation counting of aqueous suspensions or dry powders is described. The addition of 4% by weight of Cab-O-Sil (finely divided silicon dioxide) to the liquid scintillation gel produces a transparent and colorless gel which is stable for 1 to 2 weeks. Counting efficiency of 65 and 14% is reported for C$^{14}$- and H$^3$-labeled compounds, respectively, which are soluble or suspended in milk. (C.J.G.)

**10410**
MEASUREMENT OF THE URANIUM—URANIUM(III) POTENTIAL IN LiCl—KCl EUTECTIC. Dieter M. Gruen (Argonne National Lab., Lemont, Ill.) and Robert A. Osteryoung (Rensselaer Polytechnic Inst., Troy, N. Y.). Ann. N. Y. Acad. Sci. 79, 897-907(1960) Jan. 30.

Measurement of the potential of the uranium—uranium(III) couple in fused KCl—LiCl eutectic melt, with respect to a silver—silver(I) chloride reference electrode, is reported. The temperature emf behavior for the cell was determined at 452 to 534°C. (C.J.G.)

**10411**
OXIDATION STATES OF THE ELEMENTS AND THEIR POTENTIALS IN FUSED-SALT SOLUTIONS: THE ACTINIDE ELEMENTS. Dieter M. Gruen, R. L. McBeth, J. Kooi, and W. T. Carnall (Argonne National Lab., Lemont, Ill.). Ann. N. Y. Acad. Sci. 79, 941-9(1960) Jan. 30.

Experimental results concerning the oxidation states and potentials of the actinide elements in fused nitrates and chlorides are summarized. Measurements on the absorption spectra of Pu and Am in LiCl—KCl eutectic are reviewed. (C.J.G.)

**10412**
PURIFICATION OF SODIUM FROM OXIDES AND METHODS OF OXIDE CONTENT CONTROL. P. L. Kirillov, F. A. Kozlov, V. I. Subbotin, and N. M. Turchin. Atomnaya Energ. 8, 30-6(1960) Jan. (In Russian)

Oxides in sodium coolants induce corrosion in the system and cause plugging. Data are given from tests made with cold traps for catching oxides. The data are useful in designing experimental and industrial installations using sodium and sodium—potassium coolants. (tr-auth)

**10413**
ABSORPTION SPECTRA OF C$_6$H$_6$, C$_6$D$_6$, AND MIXED CRYSTALS (C$_6$H$_6$ + C$_6$D$_6$) AT 20°K. Andrée Ciais and Paul Pesteil (Faculté des Sciences, Marseille). Compt. rend. 250, 1627-9(1960) Feb. 29. (In French)

The classical coupling theory is applied to the exciton spectra of benzenes. Two possibilities are discussed, and it is suggested that benzene and deuterobenzene have different crystalline structures at 20°K. (tr-auth)

**10414**
SOME CATION SUBSTITUTIONS DURING THE FORMATION OF PHOSPHORITE FROM CALCITE. L. L. Ames, Jr. (General Electric Co., Richland, Wash.). Econ. Geol. 55, 354-62(1960) Mar.-Apr.

The nature of cation substitution during replacement of calcite by phosphorite allows the statistical treatment of data concerning such substitutions. Log-probability plots of data yield straight lines that allow easy and accurate extrapolations. Data are presented to show the effect of $PO_4^{3-}$ concentration, temperature, flow rate, and $Na^+$ concentration on the primary inclusion of the radioisotopes of $Pm^{3+}$, $Sr^{2+}$, $U^{6+}$, and $Pu^{4+}$. (auth)

**10415**

LIQUID EXTRACTION. UNIT OPERATIONS REVIEW. Robert C. Treybal (New York Univ.). Ind. Eng. Chem. 52, 262-6(1960) Mar.

The liquid extraction process is reviewed relative to developments made in the problems of extraction from single drops, motion of drops immersed in another in mixing vessels, and formation of dispersions in mixing vessels. The performance of various mixer-settlers and pulsed, packed, and rotating-disk columns is reviewed. Industrial applications of liquid extraction processes are discussed. (C.J.G.)

**10416**

ION EXCHANGE. UNIT OPERATIONS REVIEW. Robert Kunin (Rohm & Haas Co., Philadelphia) and George W. Bodamer (Electric Storage Battery Co., Yardley, Penna.). Ind. Eng. Chem. 52, 267-70(1960) Mar.

A literature survey on ion exchange developments was conducted relative to theory and applications in the treatment of water supplies, mining and metallurgical fields, organic and biochemistry studies, food technology, waste processing, catalysis, and membrane studies. The development of ion exchange materials was included in the survey. (C.J.G.)

**10417**

PARTITION OF BINARY MIXTURE OF INERT GASES IN DIRECT CURRENT DISCHARGE. N. A. Matveeva (Leningrad State Univ.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 1021-5(1959) Aug. (In Russian)

Data are tabulated which indicate that the partition of mixed gases in d-c discharges can be used for separating the gas in mixtures and for improving the sensitivity of analyses for small amounts of admixtures in cases where the ionization potential of the admixture is lower than that of the constituent gases. (R.V.J.)

**10418**

RARE EARTH METAL—METAL HALIDE SYSTEMS—THE PREPARATION OF NEODYMIUM(II) HALIDES. Leonard F. Druding and John D. Corbett (Iowa State Univ., Ames). J. Am. Chem. Soc. 81, 5512(1959).

Phase equilibrium in the $Pr-PrCl_3$, $Nd-NdCl_3$, and $Nd-NdI_3$ systems was studied. The X/M ratios were determined to be 2.34 ± 0.03 for $PrCl_3$ at 978°C; 2.00 ± 0.04 for $NdCl_3$ at 950°C; and 1.99 ± 0.05 for $NdI_3$ at 970°C. (C.J.G.)

**10419**

PROTON NMR SPECTRA OF HYDRATED CATIONS. Robert C. Axtmann (E. I. du Pont de Nemours & Co., Aiken, S. C.). J. Chem. Phys. 30, 340-1(1959) Jan.

The chemical shifts (relative to water) of eleven different solutions of nitrates were measured at 40 Mc with sample and water reference at 23 to 24°C. (C.J.G.)

**10420**

ANION EXCHANGE STUDIES. XXVI. A COLUMN METHOD FOR MEASUREMENT OF ION EXCHANGE EQUILIBRIA AT HIGH TEMPERATURE. TEMPERATURE COEFFICIENT OF THE $Br^-$-$Cl^-$ EXCHANGE REACTION. Kurt A. Kraus, Richard J. Raridon, and David L. Holcomb (Oak Ridge National Lab., Tenn.). J. Chromatog. 3, 178-89(1960).

A packed column method for the precision measurement of temperature coefficients of ion exchange equilibria was developed and equipment suitable for operation up to 200° is described. Use of the equipment is illustrated with the bromide (tracer)-chloride anion exchange system in the range 0 to 150° for which the enthalpy change was found to be a linear function of temperature. (auth)

**10421**

LIQUID SCINTILLATORS. VII. 2,5-DIARYL SUBSTITUTED THIAZOLES AS LIQUID SCINTILLATOR SOLUTES. V. N. Kerr, F. N. Hayes, D. G. Ott, and E. Hansbury (Los Alamos Scientific Lab., N. Mex.). J. Org. Chem. 24, 1861-4(1959).

A number of 2,5-diaryl substituted thiazoles were evaluated as liquid scintillator solutes. A comparison of the effect of substituent groups upon the pulse height of the thiazoles exhibited a marked improvement only with the 4-pyridyl and the p-dimethylaminophenyl groups. The thiazole pulse heights, fluorescence spectra, and ultraviolet absorption spectra were compared with the analogous oxazoles. (auth)

**10422**

LIQUID SCINTILLATORS. VIII. THE EFFECT OF THE DIALKYLAMINO GROUP. V. N. Kerr, F. N. Hayes, D. G. Ott, R. Lier, and E. Hansbury (Los Alamos Scientific Lab., N. Mex.). J. Org. Chem. 24, 1864-6(1959).

A number of dialkylamino substituted 2,5-diaryloxazoles were synthesized. The effect of the dialkylamino group upon the capability of these and other compounds to perform as liquid scintillator solutes is discussed. (auth)

**10423**

INDIRECT NUCLEAR SPIN-SPIN COUPLINGS IN SATURATED HYDROCARBON MOLECULES. Eiko Hiroike (Tokyo Inst. of Tech.). J. Phys. Soc. Japan 15, 270-84 (1960) Feb. (In English)

A general formula for the coupling constant $J_{HH'}$ between two hydrogen nuclei is derived by means of the valence bond method. Almost all the structures, which are obtained by Rumer's theorem, are taken into account. The calculated value of $J_{HH'}$ in a methane molecule is 12.1 $sec^{-1}$, which is in good agreement with experiment. It is shown that an approximate formula for $J_{HH'}$, which is derived from the general one, is convenient to discuss the qualitative behavior of $J_{HH'}$. (auth)

**10424**

FLUORINE N.S.R. SPECTROSCOPY. II. A "DISTANT" CARBON-13 ISOTOPE EFFECT. George Van Dyke Tiers (Minnesota Mining and Mfg. Co., St. Paul). J. Phys. Soc. Japan 15, 354(1960) Feb. (In English)

A nuclear spin resonance "isotope effect" upon shielding values for fluorine atoms attached to $C^{13}$ was investigated. The small excess shielding produced by "distant" $C^{13}$ is shown to vary by a statistically significant factor of two among the compounds studied in the $F-C^{12}-C^{13}$ system. No correlation is observed between this strongly varying quantity and other closely related measurements, nor to the fluorine shielding values listed for the compounds. The magnitude of the $C^{13}$ effect increases with the number of trigonal carbons in the $F-C-C^{13}$ system; this "correlation" may perhaps extend to the smaller $F-C^{13}$ system, with the opposite sign. Experiments are underway to determine the relative sign of the two $C^{13}$ coupling constants. (B.O.G.)

**10425**

THE REACTION BETWEEN LEAD(IV) AND CEROUS(III) ACETATES IN ACETIC ACID. D. Benson and L. H.

Sutcliffe (The University, Liverpool). Trans. Faraday Soc. 56, 246-54(1960) Feb.

A kinetic study of the reaction between Pb(IV) and Ce(III) in acetic acid led to the postulations that Pb(III) is an intermediate and that the reacting entities can be ions. In the presence of sodium acetate, the reacting species are considered to be $Ce(OAc)_4^-$ and $Pb(OAc)_5^-$ or $Pb(OAc)_6^{2-}$. The addition of ethanol gave rise to a reactive complex formed between Pb(IV) and the ethanol. (auth)

**10426**

POTENTIOMETRIC STUDY ON THE FORMATION OF MIXED URANYL AND ALKALINE ELEMENT FERROCYANIDES. V. D. Ponomarev and I. V. Tananaev (Moscow Physical Engineering Inst.). Zhur. Anal. Khim. 15, 10-15 (1960) Jan.-Feb. (In Russian)

It is established that the position of the equivalent point corresponding to the bend of the oxidation-reduction potential curves in the systems of the type: $UO_2^{2+}-M_4[Fe(CN)_6]-H_2O$ (M = Li, Na, K, Rb, Cs) depends on the nature of an alkaline element present in the solution. When lithium ferrocyanide is present a normal uranyl cyanide $(UO_2)_2[Fe(CN)_6]$ is formed. In the presence of the excess of alkaline element ions the equivalent point shifts to the formation of compounds containing large quantities of alkaline elements; whereas in the presence of very large concentrations of the solutions of alkaline element chlorides a mixed uranyl ferrocyanide is formed: $4(UO_2)_2[Fe(CN)_6] \cdot 3M_4[Fe(CN)_6]$. The mixed uranyl ferrocyanides are suggested to be polynuclear molecules of the polymer type. (auth)

**10427**

SEPARATION OF SOME FISSION ISOTOPES BY THE FOCUSING ION-EXCHANGE. V. P. Shvedov, Ten Ten, and A. V. Stepanov (Lensovet Inst. of Tech., Leningrad). Zhur. Anal. Khim. 15, 16-19(1960) Jan.-Feb. (In Russian)

Separation of mixtures $Sr^{90}-Y^{90}$, $Sr^{90}-Y^{90}-Ce^{144}$, $Ce^{144}-La^{140}$, and Ce−Pr by the focusing ion exchange method was studied. It was established that the mixtures $Sr^{90}-Y^{90}$, $Sr^{90}-Y^{90}-Ce^{144}$, and $Ce^{144}-La^{140}$ can be separated in 5 min with the use of citric acid or complexone III; the separation of the Ce−Pr mixture at the concentrations up to 0.5 mg/ml is not complete. (auth)

**10428**

ON THE SOLUBILITY OF ZIRCONIUM CUPFERRONATE. S. V. Elinson and T. I. Nezhnova. Zhur. Anal. Khim. 15, 73-6(1960) Jan.-Feb. (In Russian)

The equilibrium constant for the precipitation of zirconium with cupferron was determined to be $3.36 \times 10^{19}$. The solubility product $(2.35 \times 10^{-37})$ and the solubility of zirconium cupferronate were calculated by means of the equilibrium constant. The estimated value for solubility of $1.6 \times 10^{-8}$ M/l agrees fairly well with previously published data. (auth)

**10429**

INVESTIGATION INTO THE THERMODYNAMIC PROPERTIES OF LIQUID METAL SOLUTIONS OF POTASSIUM WITH THALLIUM, LEAD AND BISMUTH. M. F. Lantratov and A. F. Alabyshev (Ul'yanov (Lenin) Leningrad Electrotechnic Inst.). Zhur. Fiz. Khim. 33, 2429-34(1959) Nov. (In Russian)

The thermodynamic properties of binary liquid potassium alloys with thallium, lead, and bismuth were studied by the emf method. For all systems considerable deviations from the Raoult Law were established, by assuming the existence of metallic compounds between potassium and thallium, and lead and bismuth. Large negative deviations in the excess entropy of mixing are connected with the ionic character of the bonds in the compounds. (tr-auth)

**10430**

PROCESS FOR THE PREPARATION OF URANIUM TRICHLORIDE. (to United Kingdom Atomic Energy Authority). British Patent 829,491. Mar. 2, 1960.

A process is described in which $UCl_3$ is produced from higher U chlorides by reduction with $H_2$ at high temperature and pressure. In an example, $UCl_5$ was heated at 275°C to produce $UCl_4$ which was placed in a tube and heated to 525°C in a slow $H_2$ stream at 7 atm. After 30 min the temperature was raised to 550°C for 30 min. The product was very pure $UCl_3$. (T.R.H.)

**10431**

IMPROVEMENTS IN OR RELATING TO PROCESSES FOR THE PRODUCTION OF GRAPHITE. (to General Electric Co., Ltd.). British Patent 830,662. Mar. 16, 1960.

A method is given for producing graphite which is relatively impermeable to fluids. The graphite is exposed to nickel carbonyl in $H_2$ at 200 to 500°C to deposit Ni on the surface. A heat treatment at 1200 to 1400°C stabilizes the coating. (T.R.H.)

**10432**

IMPROVEMENTS IN OR RELATING TO PRODUCTION OF CARBON. John Malcolm Hutcheon (to United Kingdom Atomic Energy Authority). British Patent 830,379. Mar. 16, 1960.

A method of producing carbon is described. In an example, reformer residue oil at 100 psi circulates past a carbon rod heated to 500°C. Over a period of 90 min the interior of the rod had to be heated to 900°C to maintain the 500°C surface temperature. The oil is filtered in the loop and re-enters the heater at 50°C. Exit temperature varies between 150 and 200°C. At the end of the period a carbon deposit of 1.5 to 2 mm was built up on the rod. Nuclear fuel elements can be coated by the process. (T.R.H.)

## Analytical Procedures

**10433** AERE-AM-57

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

THE SPECTROGRAPHIC ANALYSIS OF INORGANIC NON-METALLIC MATERIALS BY THE BARIUM CHLORIDE FLUX METHOD. J. C. Cotterill. Nov. 1959. 15p. (BIS).

The spectrographic analysis of inorganic non-metallic materials by the barium chloride flux method is described. The powdered sample is mixed with anhydrous barium chloride, pressed into pellets, and spectrographed on graphite electrodes using the direct-current arc. Sample spectra are compared visually with standard spectra. (C.J.G.)

**10434** BMI-1415

Battelle Memorial Inst., Columbus, Ohio.

RADIOMETRIC METHODS FOR THE DETERMINATION OF MAGNESIUM AND CALCIUM IN PORTLAND CEMENT. Charles T. Brown, James E. Howes, Jr., Thomas S. Elleman, Charles W. Townley, and Duane N. Sunderman. Feb. 18, 1960. 13p. Contract W-7405-eng-92. OTS.

Radiometric methods of analysis for magnesium and calcium have been developed as part of a program for the U. S. Atomic Energy Commission, Office of Isotopes Development, which are applicable to the determination of these elements in portland cement. Both methods employ, as a precipitant, a standard solution of $(NH_4)_2HPO_4$ labeled with phosphorus-32. In the presence of $NH_4OH$, this reagent precipitates $MgNH_4PO_4$ or $Ca_3(PO_4)_2$ from a solution of magnesium or calcium ions. The reduction in the radioactivity level of the labeled phosphate solution after precipitation serves as a measure of the phosphate reacted and thus a measure of the quantity of magnesium or calcium present. Studies have been made of the effects of reagent concentration, $NH_4OH$ concentration, and other experimental variables. The interference of other elements present normally in portland cement and its raw materials has been determined. The concentration ranges for highest accuracy have been found to be 5 to 15 mg of MgO per 100 ml and 15 to 30 mg of CaO per 50 ml. (auth)

**10435** CEA-1204
France. Commissariat à l'Énergie Atomique, Paris.
DOSAGE SPECTROGRAPHIQUE DU BERYLLIUM DANS L'ATMOSPHERE. (Spectrographic Determination of Beryllium in the Atmosphere). G. Soudain and T. Morawek. 1959. 8p.

Since the apparatus for continuous determination of beryllium is not yet perfect, a discontinuous method was developed. The air to be analyzed is filtered, and the dust laden filter is dissolved in a mixture of sulfuric and nitric acid. The pH and the conductivity of the solution obtained were adjusted to standard values, and it was then analyzed spectrographically by the rotating sector method. Up to $0.01 \times 10^{-6}$ of Be per $cm^3$ of solution can be detected. The precision is of the order of 10 per cent. (auth)

**10436** CEA-1217
France. Commissariat à l'Energie Atomique, Paris.
DETERMINATION PAR ACTIVATION NEUTRONIQUE DE LA CONCENTRATION D'URANIUM-235 DANS DES OXYDES D'URANE. (Determination by Neutron Activation of the Uranium-235 Concentration in Uranium Oxides). S. May and P. Leveque. 1959. 7p.

Classical methods of measuring isotopic abundance have the disadvantage of being long and of requiring chemical separation. A non-destructive method of measuring the uranium-235 content is described. It is based on an overall measurement of the short-lived fission product activity formed during a 15 sec neutron irradiation. The precision is of the order ±1.5 per cent for 20 per cent enriched samples. The error due to the contribution from fast fission is discussed in detail. (auth)

**10437** CEA-1225
France. Commissariat a l'Energie Atomique, Paris.
RECHERCHE DU STRONTIUM MINERAL RADIOACTIF $^{90}$Sr DANS LES URINES. (Determination of Radioactive Mineral Strontium-90 in Urine.) L. Jeanmaire, H. Jammet, and S. Bertrand. 1959. 10p.

An analytical procedure for radioactive strontium in urine is described. As a first step, a precipitation of calcium oxalate is performed on the urine to detect the presence of various fission products and particularly of strontium which is carried by the precipitate. Strontium can then be selectively separated on ion exchange resins. By studying the growth curve of $\beta$ activity, it is possible to determine the activities which may be attributed to $Sr^{89}$ and $Sr^{90}$, respectively. (auth)

**10438** CEA-1227
France. Commissariat à l'Energie Atomique, Paris.
DOSAGE DU THORIUM NATUREL DANS LES URINES. (Determination of Natural Thorium in Urine.) L. Jeanmaire and H. Jammet. 1959. 6p.

A procedure for the qualitative analysis of thorium in urine is described. After precipitation with ammonium hydroxide, dissolution of the precipitate, extraction at pH 4 to 4.2 with cupferron in chloroformed solution and mineralization, a colorimetric determination of thorium with thorin is performed. It is thus possible to detect about 2 $\gamma$ of thorium in the sample. (auth)

**10439** CI-R-57
Gt. Brit. Springfields Works, Springfields, Lancs, England.
SPECTROGRAPHIC DETERMINATION OF TRACE AMOUNTS OF ALUMINUM IN BLACK URANIUM OXIDE. E. P. Bridge, R. Franklin, and A. Marshall. Apr. 1952. 7p.

An investigation into the possibility of determining aluminum in black uranium oxide by a carrier distillation technique has been carried out. A method was successfully developed which is usable in a concentration range of 5 to 1000 ppm aluminum with a precision of ±12%, sodium fluoride being used as a carrier. The spectra have been evaluated by means of a non-recording microphotometer.

**10440** CI-R-78
Gt. Brit. Springfields Works, Springfields, Lancs, England.
DETERMINATION OF FLUORINE AND CHLORINE IN CHLORINE TRIFLUORIDE. A. E. Sawyer, M. Hall, and D. A. Skinner. Aug. 19, 1953. 10p.

A method has been developed for the determination of fluorine and chlorine in chlorine trifluoride. Chlorine trifluoride vapor is passed through a known weight of dry sodium chloride, contained in a copper tube. Sodium fluoride is produced and the free chlorine which is liberated is absorbed in sodium hydroxide solution. After decomposition of the sample, chlorine and fluorine are determined in the sodium chloride/fluoride mixture and in the sodium hydroxide solution. From the known weight of sodium chloride used the chloride contributed by the sample can be calculated. The chloride is determined by Mohr's method and the fluoride is titrated with thorium nitrate using alizarin red as indicator. (auth)

**10441** DP-449
Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.
AN IMPROVED ACID SATURATION METHOD FOR THE DETERMINATION OF TRI-n-BUTYL PHOSPHATE. Woodfin E. Shuler. Dec. 1959. 9p. Contract AT(07-2)-1. OTS.

The quantitative determination of tri-n-butyl phosphate (TBP) in kerosene solutions may be accomplished rapidly and accurately by an improved acid saturation method. Use is made of the constant distribution coefficient of 12-14M $HNO_3$ between the aqueous acid solution and the solution of TBP in kerosene. (auth)

**10442** NAA-SR-Memo-4188
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
AUTOMATIC SPECTROPHOTOMETRY FOR CHROMATOGRAPHIC SEPARATIONS. R. M. Kramer. July 31, 1959. 25p. OTS.

Analytical methods for OMR coolants were investigated. The utility of an automatic monitoring ultraviolet spectrophotometer was demonstrated by its use in the chromatographic separation of a synthetic sample of diphenyl, terphenyls, and triphenylene. The mixture was chosen as being characteristic of all types of compounds used as organic moderated reactor coolants. (J.R.D.)

**10443** NP-8398
Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw.
UNTERSUCHUNGEN ÜBER DIE FLAMMENPHOTOMET-

RISCHE GALLIUM, INDIUM, UND THALLIUMBESTIMMUNG. (Research on the Flame Photometric Determination of Gallium, Indium, and Thallium). Report No. 113/VIII. J. Malinowski, D. Dancewicz, and S. Szymczak. Sept. 1959. 9p.

Investigations which were made to establish the suitability of the flame photometer for the quantitative determination of indium and thallium are described. For comparison and for the flame photometric determination of gallium, a "Uvispek" spectrophotometer was used. It was established that the anion perturbation of the emission common for alkaline earths does not occur in gallium, indium, and thallium. (tr-auth)

**10444** PGR-66(W)
United Kingdom Atomic Energy Authority. Production Group. Chemical Services Dept., Windscale, Sellafield, England.
ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF URANIUM IN REACTOR FUEL PROCESSING PLANT SOLUTIONS (THIOCYANATE PROCEDURE). Jan. 1960. 5p. BIS.

Samples containing large quantities of Cr and Fe are extracted with ether and the U is determined absorptiometrically as the thiocyanate complex. Other samples are analyzed directly without preliminary oxidation of organic matter. (J.R.D.)

**10445** SCS-M-25
Gt. Brit. Springfields Works, Springfields, Lancs, England.
THE DETERMINATION OF CHLORIDE IN URANIUM RODS. Mar. 26, 1953. 11p.

A method for the determination of chloride in uranium rods is presented. The chloride is co-precipitated with silver iodide and the silver removed by treatment of the precipitate with ammonium hydroxide and zinc. The iodide is oxidized to iodine and removed by extraction with benzene. The chloride is determined potentiometrically using a silver chloride electrode. (auth)

**10446** SCS-M-31B
Gt. Brit. Springfields Works, Springfields, Lancs, England.
THE ABSORPTIOMETRIC DETERMINATION OF LEAD IN URANIUM METAL. May 28, 1953. 5p.

The lead is extracted with dithizone from an ammoniacal citrate solution containing cyanide and hydroxylamine. The excess dithizone is removed by an ammonia-cyanide wash and the lead dithizonate measured absorptiometrically. The method is suitable for amounts of lead in the range 0 to 100 ppm. (auth)

**10447** SCS-M-106
Gt. Brit. Springfields Works, Springfields, Lancs, England.
THE DETERMINATION OF OXYGEN IN MIXTURES OF NITROGEN AND ETHER VAPOUR. May 23, 1953. 9p.

The quantity of cupric salt formed when a sample of the gas is shaken with cuprous ammonium chloride is determined iodometrically. The analysis is applicable at concentrations of 0 to 10% oxygen. (J.R.D.)

**10448** SCS-Memo-41
Gt. Brit. Springfields Works, Springfields, Lancs, England.
INCREASED PRECISION OF THE METHOD FOR THE DETERMINATION OF U-235 ABUNDANCE BY RADIOACTIVATION. A. P. Seyfang. Oct. 22, 1953. 7p.

Development work to increase the precision of the radioactivation method for slightly enriched or depleted $U^{235}$ samples is described. It is shown that results may now be obtained with a precision (3 × coefficient of variation) of ±1.3%. The chemical error contributes little to the total error. Suggestions are made for still further increasing the precision. (auth)

**10449** SCS-R-143
Gt. Brit. Springfields Works, Springfields, Lancs, England.
DETERMINATION OF MOLYBDENUM IN CRUDE URANIUM PEROXIDE. A. B. Crowther and J. Benson. Mar. 6, 1950. 9p.

A method is proposed for the determination of molybdenum in crude uranium peroxide, whereby the intensity of yellow color produced when thioglycolic acid is added to an acid solution of molybdenum is measured absorptiometrically. A preliminary separation of the molybdenum is necessary, and extraction of its chloroform soluble cupferrate from hydrochloric acid solution provides a suitable method. (auth)

**10450** SCS-R-145
Gt. Brit. Springfields Works, Springfields, Lancs, England.
SPECTROGRAPHIC DETERMINATION OF LITHIUM, POTASSIUM AND BARIUM IN CALCIUM BASE MATERIALS BY THE CARRIER DISTILLATION METHOD. P. A. Serin. July 27, 1950. 13p.

A method was developed for the estimation of lithium, potassium, and barium in calcium oxide by the carrier distillation technique using a sodium chloride carrier. The method may be applied to any calcium base materials that can be converted to high bulk density calcium oxide without loss of lithium, potassium, and barium. (auth)

**10451** SCS-R-146
Gt. Brit. Springfields Works, Springfields, Lancs, England.
THE DETERMINATION OF FREE ACIDITY IN AQUEOUS SOLUTIONS OF URANYL NITRATE USING AN EXTRACTION PROCEDURE. PART I. J. R. Sanderson. Mar. 20, 1950. 12p.

A method was devised for the determination of free acidity in aqueous uranyl nitrate solutions. The method depends upon the use of a reagent which complexes the uranium and the major impurities and the salt of an organic acid possessing a favorable dissociation constant, in addition to a suitable partition coefficient with respect to water and immiscible organic solvents. By this means, an equivalent quantity of the organic acid, in the present case benzoic acid, is liberated by the free nitric acid and is transferred into the solvent layer, chloroform, while uranium is complexed by potassium oxalate. The solvent layer, containing the liberated organic acid is titrated with alcoholic potassium hydroxide. (auth)

**10452** SCS-R-174
Gt. Brit. Springfields Works, Springfields, Lancs, England.
THE DETERMINATION OF COPPER IN URANIUM ORES, PLANT INTERMEDIATES AND URANIUM METAL. A. B. Crowther and H. T. Neville. Dec. 19, 1950. 13p.

A method for the separation of 0 to 5 mg of copper from uranium solutions using dithizone is described. The separated copper can then be estimated absorptiometrically either with ammonia (1 to 5 mg) or sodium diethyl dithio carbamate (0 to 1 mg). The method can be applied to solutions containing impurities of the order found in high-grade uranium ores. (auth)

**10453** SCS-R-200
Gt. Brit. Springfields Works, Springfields, Lancs, England.
THE SPECTROGRAPHIC DETERMINATION OF IMPURI-

TIES IN SODIUM DICHROMATE. R. Orrell. Jan. 30, 1952. 12p.

A method was developed for the spectrographic determination of impurities in sodium dichromate. The material is excited in a direct current arc on copper electrodes aligned with a large quartz spectrograph. The impurities are estimated by comparing the sample spectra with standard spectra containing known amounts of added elements and using the chromium spectrum as an internal standard. The method is an adaptation of the iron flux technique. The limits of detection however are slightly higher than in the iron flux method, this being attributed to suppression of the spectrum by the high sodium content of the material. (auth)

**10454** SCS-R-252

Gt. Brit. Springfields Works, Springfields, Lancs, England.

THE SPECTROGRAPHIC DETERMINATION OF RARE EARTHS IN FERROUS SULPHATE (CONCENTRATION). C. J. Riley and S. Newton. July 6, 1951. 8p.

A method for the determination of rare earths in ferrous sulfate is given. The method consists of double co-precipitation of the rare earths with calcium oxalate, followed by double co-precipitation with ferric hydroxide. (C.J.G.)

**10455** SCS-R-328

Gt. Brit. Springfields Works, Springfields, Lancs, England.

THE DETERMINATION OF ARSENIC IN HYDROLYSED URANIUM HEXAFLUORIDE. PART I. A MODIFIED HERON AND ROGERS METHOD. J. A. Ryan, J. R. Sanderson, and T. Mason. Oct. 22, 1953. 12p.

A method for the determination of arsenic in hydrolyzed uranium hexafluoride solutions is described. AsIII or AsV is reduced to arsine in an electrolytic cell containing a mercury cathode and platinum anode. The liberated arsine is oxidized to arsenate in an iodine/bicarbonate solution and is finally determined colorimetrically as the molybdenum blue complex. Attack on the glass cell is prevented by forming the aluminofluoride ion. To accomplish this, a sevenfold excess of aluminum sulfate over that required to form $(AlF_6)'''$ is added to the fluoride-containing sample solution. Phosphates are not reduced to phosphine in the cell and it has been shown that 2000 μg of phosphorus does not interfere with the determination. (auth)

**10456** SCS-R-393

United Kingdom Atomic Energy Authority. Industrial Group. Springfields Works, Springfields, Lancs, England.

THE DETERMINATION OF URANIUM TETRAFLUORIDE IN THE PRESENCE OF URANIUM METAL, URANIUM OXIDES, URANYL FLUORIDE AND MAGNESIUM FLUORIDE. G. I. Goodfellow and J. A. Ryan. Sept. 10, 1954. 9p. (ARDC/P-31).

It is shown that if uranium tetrafluoride is dissolved in a boiling solution of ethylene diaminetetraacetic acid (disodium salt), the solution so formed is stable for at least one hour and may be titrated quantitatively with potassium dichromate. Uranium metal, uranium dioxide, and uranosouranic oxide do not interfere provided the fluoride ions are complexed with boric acid. Uranium trioxide and uranyl fluoride dissolve but are not titrated. The method devised can be applied to slags assuming that only the above compounds of uranium are present. (auth)

**10457** WAPD-CTA(GLA)-201

Westinghouse Electric Corp. Bettis Plant, Pittsburgh.

THE DETERMINATION OF URANIUM IN URANIUM ZIRCONIUM ALLOYS. G. W. Goward, V. R. Wiederkehr, and O. J. Brvenik. Apr. 18, 1956. 8p. Contract AT-11-1-GEN-14. OTS.

A method for determination of U in U–Zr alloys containing negligible quantities of interfering impurities is described. Interfering elements such as Fe or Cr may be removed by electrolysis with a mercury cathode after dissolution and fuming. (J.R.D.)

**10458** WAPD-CTA(GLA)-536

Westinghouse Electric Corp. Bettis Plant, Pittsburgh.

THE DETERMINATION OF TOTAL URANIUM IN HIGH PURITY URANIUM DIOXIDE BY IGNITION. G. W. Goward and V. R. Wiederkehr. Feb. 21, 1958. 3p. Contract AT-11-1-GEN-14. OTS.

The sample is ignited to $U_3O_8$ at 800 to 820°C. The uranium content is determined by the increase in weight. Nonvolatile foreign material in excess of 0.05% interferes. (J.R.D.)

**10459** WAPD-M(GLA)-790

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

LABORATORY MANUAL; METHODS FOR THE CHEMICAL AND SPECTROCHEMICAL ANALYSIS OF ZIRCONIUM AND ZIRCALOY. G. W. Goward and R. M. Jacobs, eds. Nov. 1959. 170p. Contract AT-11-1-GEN-14. OTS.

Issued in loose-leaf form to facilitate periodic revisions.

The chemical and spectrochemical methods of Bettis Atomic Power Laboratory for analysis of Zr sponge and Zircaloy are given in a form suitable for direct lab use. (T.R.H.)

**10460** WSL/M-692A

[United Kingdom Atomic Energy Authority. Industrial Group. Windscale Works, Sellafield, Cumb., England].

TITRIMETRIC DETERMINATION OF PLUTONIUM IN PLUTONIUM NITRATE SOLUTIONS (SILVER REDUCTOR-CERIC SULPHATE METHOD). F. Barker. Aug. 7, 1957. 5p.

The method is intended primarily for sampling in the metal finishing plant. After removal of $HNO_3$, the Pu is reduced to the trivalent state, using a silver reductor, and then titrated to the tetravalent state with standard $Ce(SO_4)_2$ solution. (W.L.H.)

**10461** WSL-R-44

Gt. Brit. Windscale Works, Sellafield, Cumb., England.

THE DETERMINATION OF NICKEL IN PLUTONIUM METAL. J. K. Foreman and W. T. Appleton. Oct. 2, 1952. 13p.

The marked differences in ion exchange potential of trivalent plutonium and divalent nickel in dilute hydrochloric acid was ultilized to secure a complete separation of microgram quantities of nickel from milligram amounts of plutonium, using cation exchange resins. Selective elution of nickel by complexing with potassium cyanide was attempted and the normal dimethylgloxime method for the absorptiometric determination of nickel was modified for use in the presence of considerable excess of cyanide ion. (auth)

**10462** AEC-tr-3987

THE DETERMINATION OF HYDROXYL GROUPS IN EPOXIDE RESINS. A. Bring and Fr. Kadlecek. Translated for Los Alamos Scientific Lab. from Plaste u. Kautschuk 5, No. 2, 43-8(1958). 17p. JCL.

Procedures are given which allow the determination, with good accuracy, of the sum of the epoxy and hydroxyl groups in epoxide resins of molecular weights up to 1000. Of the various acrylating agents used, a mixture of stearyl chloride in chloroform produced results which were closest to theoretical calculations. (C.J.G.)

**10463** AEC-tr-4001
POLAROGRAPHY WITH A VIBRATING PLATINUM ELECTRODE. W[ilhelm] Dirscherl and K[laus] Otto. Translated by Margaret V. Colven (Savannah River Lab.) from Leybold polarograph. Ber. 1, No. 3, 49-52(1953). 5p. JCL.

Determination of oxygen in the presence of chlorine using a vibrating platinum micro-electrode polarograph is described. It was found that reproducible waves could be obtained with the vibrating platinum electrode in all cases as long as the amplitude of the electrode was held constant and the proper volume of solution was maintained. (J.R.D.)

**10464** AEC-tr-4007
APPLICATIONS OF ION EXCHANGE SUBSTANCES IN ANALYTICAL CHEMISTRY. [PART] XIII. Ralph Djurfeldt, Jenny Hansen, and Olof Samuelson. Translated by K. Bevis (Savannah River Lab.) from Svensk Kem. Tidskr. 59, 14-18(1947). 9p. JCL.

The separation of cations was studied using an organic exchanger. Solutions of acetate and oxalate were percolated through a layer of $H^+$ exchanger. Cases of quantitative separation for several acetates and oxalates are listed. It is noted that due to stable complexes in solutions containing aluminum or ferric oxalate, the separation in these cases is incomplete. Separations of Fe, Al, and Be from solutions of $FeCl_3$, $AlCl_3$, and $BeSO_4$ of various concentrations were also investigated. It is not possible to exchange Fe for H ions in dilute solutions of $FeCl_3$; however, the hydrolysis of $AlCl_3$ and $BeSO_4$ does not prevent quantitative ion exchange in these cases. (J.R.D.)

**10465**
DETERMINATION OF STRONTIUM-90 IN STILLBORN BONES. Eduardo Penna-Franca and Aristides Pinto Coelho (Univ. of Brazil, Rio de Janeiro). Anais acad. brasil. cienc. 31, 49-52(1960). (In Spanish)

A series of radiochemical analyses of Sr-90 in stillborn bones was run in the first semester of 1958. The bones were all collected in Rio de Janeiro. The analytical method was the one recommended by the Health and Safety Laboratory U.S.A., A.E.C. Two samples were analyzed by the procedure of Kulp et al. (1957) with slight modifications. The results obtained, expressed in Sunshine Units ($\mu\mu$ C Sr-90/$_{g\ Ca}$) fell in the range of 0.26 to 0.78 S.U. with an average of ten samples of 0.51 ± 0.19 $\mu\mu$ C Sr-90/$_{g\ Ca}$. The results are of the same order of magnitude as the ones found by other laboratories in different countries. This seems to confirm that the contamination by Sr-90 is more or less uniform over large areas of the world. On interpreting these results however it should be taken into consideration that the bones analyzed belonged to children of indigent mothers, who have a very low intake of calcium in their diet. (auth)

**10466**
SIMULTANEOUS EXTRACTION AND SPECTROPHOTOMETRIC DETERMINATION OF CERIUM WITH 2-THENOYLFLUOROACETONE. Shripad M. Khopkar and Anil K. De (Jadavpur Univ., Calcutta). Anal. Chem. 32, 478-80(1960) Apr.

A colorimetric method was developed for the determination of milligram amounts of cerium(IV) on the basis of a color reaction with 2-thenoyltrifluoroacetone in benzene. The bright orange-red cerium(IV)-TTA chelate solution (in benzene) follows Beer's law at 450 mμ over the range of 3 to 40 γ of cerium(IV) per ml. At pH 4.0 to 6.0, 80% or more of cerium(IV) is removed from an aqueous solution of TTA-benzene in a single extraction. The colored system is stable for 2.5 hours. The determination can tolerate equal amounts of silver, manganese, copper, and cobalt, whereas nickel, bismuth, aluminum, thorium, uranium(VI), citrate, tartrate, and EDTA seriously interfere. The method is accurate and reproducible to within ±2% and offers a procedure for simultaneous extraction and determination of cerium(IV). (auth)

**10467**
DETERMINATION OF ZIRCONIUM IN URANIUM FISSIUM ALLOYS. Harold B. Evans, Alice M. Hrobar, and James H. Patterson (Argonne National Lab., Lemont, Ill.). Anal. Chem. 32, 481-3(1960) Apr.

Two methods are presented for the separation of zirconium from uranium fissium alloy. One method separates zirconium, molybdenum, and palladium from the other components by precipitation with cupferron. Zirconium is separated from molybdenum and palladium by successive precipitation with ammonium hydroxide. The other method consists of ammonium hydroxide precipitations, followed by precipitation with p-chloromandelic acid. The zirconium is determined spectrophotometrically as the alizarin sulfonate lake. (auth)

**10468**
LIQUID SCINTILLATION COUNTING OF TRITIATED ORGANIC COMPOUNDS. Marvin L. Whisman, Barton H. Eccleston, and F. E. Armstrong (Bureau of Mines, Bartlesville, Okla.). Anal. Chem. 32, 484-6(1960) Apr.

The parameters involved in liquid scintillation counting techniques are evaluated. From these evaluations, a routine procedure for measuring the radioactivity of tritiated organic compounds and the confidence limits of results were established. (auth)

**10469**
ADSORPTION OF THE ELEMENTS FROM HYDROFLUORIC ACID BY ANION EXCHANGE. J. P. Faris (Argonne National Lab., Lemont, Ill.). Anal. Chem. 32, 520-2(1960) Apr.

Elution characteristics for some 50 elements in a hydrofluoric acid medium were studied with a strongly basic anion exchange resin. Estimates of distribution coefficients in 1 to 24M acid were obtained by spectrographic analysis of column effluent solutions. Possible analytical separations are suggested from the adsorption data observed for elements in this medium. (auth)

**10470**
SQUARE-WAVE POLAROGRAPHY OF PLUTONIUM. Karl Koyama (General Electric Co., Richland, Wash.). Anal. Chem. 32, 523-4(1960) Apr.

The application of a square-wave polarograph to small amounts of plutonium in hydrochloric and nitric acid solutions was studied. Plutonium concentrations below $10^{-5}$ mole per liter were determined in these acids with a stationary platinum electrode. The derivative wave heights were proportional to concentration as predicted by the square-wave theory. Half-wave reduction potentials obtained for the plutonium(IV) to (III) couple agree with accepted values. The method exhibits higher sensitivity than conventional polarography, no effects from sample agitation, and negligible effects from irreversibly reduced materials, such as oxygen, on the measurement of plutonium ions. (auth)

**10471**
THE ANALYTICAL CHEMISTRY OF ZIRCONIUM. A REVIEW. G. W. C. Milner and J. W. Edwards (Atomic Energy Establishment, Harwell, Berks, Eng.). Analyst 85, 86-97(1960) Feb.

A review is presented on various analytical techniques for determining zirconium. Methods of separation discussed include precipitation, ion exchange, solvent extraction, and chromatography. Various gravimetric, volumetric, and absorptiometric methods of determination are reviewed. (C.J.G.)

**10472**

A POLAROGRAPHIC DETERMINATION OF TRACE AMOUNTS OF LEAD IN ZIRCONIUM AND ITS ALLOYS. D. F. Wood and H. A. Nicholls (Imperial Chemical Industries Ltd., Birmingham, Eng.). Analyst 85, 139-46 (1960) Feb.

A method was developed for determining lead in reactor-grade zirconium and zirconium alloys. The procedure involves a preliminary separation of the lead–diethyldithiocarbamate complex and subsequent determination of the metal by using a cathode-ray polarograph. The procedure is satisfactory over the range 20 to 100 ppm of lead. Iron and molybdenum interfere, but interference by amounts up to at least 1 and 2.5%, respectively, can be overcome by a preliminary extraction with diethyl ether from acid solution. (auth)

**10473**

APPARATUS FOR THE ROUTINE DETERMINATION OF THE OXYGEN CONTENT OF BERYLLIUM METAL BY ACTIVATION. R. F. Coleman and J. L. Perkin (United Kingdom Atomic Energy Authority, Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Analyst 85, 154-5(1960) Feb.

An apparatus is described for the determination of O in Be. The method employs irradiation of the sample by a deuteron beam and subsequently counting the $N^{16}$ activity. (C.J.G.)

**10474**

SEPARATION OF NIOBIUM AND TANTALUM TOGETHER FROM TITANIUM. V. T. Athavale, V. P. Madhava Menon, and Ch. Venkateswarlu (Atomic Energy Establishment, Trombay, India). Analyst 85, 208-11(1960) Mar.

The preferential formation of a stable complex of titanium with a mixture of oxalate and ethylenediaminetetraacetic acid in alkaline medium was utilized to separate niobium and tantalum together from titanium under suitable conditions. (auth)

**10475**

INSTRUMENTATION FOR BERYLLIUM ASSESSMENT. H. Bisby (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Power 5, No. 47, 100-3(1960) Mar.

A description of apparatus for the radiometric analysis of beryllium is given. Both the laboratory and field types of instruments described employ $BF_3$ counters. The efficiency and performance of these instruments are discussed. (C.J.G.)

**10476**

COLORIMETRIC DETERMINATION OF BORON IN NITRATE SOLUTIONS. W. J. Ross and J. C. White (Oak Ridge National Lab., Tenn.). Talanta 3, 311-17(1960) Feb.

A method for the determination of microgram amounts of boron in nitrate solutions is presented. Nitrate is destroyed with formic acid and sulfuric acid under reflux conditions. As much as 3 mM of nitrate were reduced completely by refluxing 1 ml of the nitrate solution with 1 ml of 88% formic acid for 15 minutes. Boron was determined by the carminic acid method after forming the colored complex in situ. This method was applied to the determination of boron in uranyl nitrate solutions after extraction of uranium with tri-n-octylphosphine oxide dissolved in cyclohexane. (auth)

**10477**

DETERMINATION OF DEUTERIUM IN ORGANIC COMPOUNDS BY INFRARED SPECTROPHOTOMETRY. R. Norman Jones and Marjory A. MacKenzie (National Research Council of Canada, Ottawa). Talanta 3, 356-63 (1960) Feb.

Modifications are proposed to the Trenner–Arison–Walker method for the micro-analysis of deuterium in organic compounds which involves oxidation of the compound with copper oxide in a sealed tube, collection of the water by vacuum distillation, and analysis of the water by infrared spectrophotometry. These modifications principally affect the methods of sample handling and water collection. Difficulties associated with temperature changes on the spectrophotometry of the deuterium-enriched water are overcome by differential analysis against natural-abundance water using a double-beam spectrophotometer. (auth)

**10478**

SPECTROGRAPHIC DETERMINATION OF ALUMINIUM IN URANIUM. E. A. Vernyi and V. N. Egorov. Zhur. Anal. Khim. 15, 24-6(1960) Jan.-Feb. (In Russian)

A spectrographic method for determining small amounts of aluminum in uranium based on fractional distillation with a carrier is given. The effect of barium and carbon powder on the intensity of aluminum lines was studied. The influence of third elements on the results of the aluminum determination was studied. (auth)

**10479**

SPECTROGRAPHIC DETERMINATION OF RARE EARTH ADMIXTURES IN SAMARIUM AND EUROPIUM. V. L. Kustas and G. V. Lazebnaya. Zhur. Anal. Khim. 15, 57-60(1960) Jan.-Feb. (In Russian)

A method for the quantitative determination of rare earth admixtures in pure samarium and europium oxides was developed. The determination is possible within the limits 0.01 to 4%; 0.002 to 5%. The mean relative error is 3 to 5%. The minimum quantity of substance necessary for the analysis is 5 to 10 mg. (auth)

**10480**

COMPLEXOMETRIC DETERMINATION OF ZIRCONIUM. V. F. Lukyanov and E. M. Knyazeva. Zhur. Anal. Khim. 15, 69-72(1960) Jan.-Feb. (In Russian)

The sample is decomposed by a suitable method from which zirconium is precipitated with $NH_4OH$ or NaOH. The precipitate is dissolved in 2 N HCl and boiled with the excess of complexone III. The solution is brought to pH 2.3 to 2.4 and the excess of complexone is titrated with $Th(NO_3)_4$ using uranon (arsenazo) as an indicator. The experimental error does not exceed ±0.6% relative. The method was applied to the determination of zirconium in ores, cakes, and concentrates, containing 2 to 40% zirconium, with satisfactory results. (auth)

**10481**

DETERMINATION OF URANIUM BY AMPEROMETRIC TITRATION. V. F. Eskevich and L. A. Komarova. Zhur. Anal. Khim. 15, 84-7(1960) Jan.-Feb. (In Russian)

A method is suggested for the amperometric titration of uranium (up to 1 $\mu$g/l) with ammonium vanadate solution. The accuracy of the method is 2 to 3%. The titration is carried out without applying the external potential vs. the bismuth reference electrode. The sample is prepared by the hydrosulfite-phosphate or chromium-phosphate method. (auth)

**10482**

DETERMINATION OF SMALL AMOUNTS OF BERYLLIUM BY MEANS OF β-DIKETONES. E. S. Przhevalskii and L. M. Moiseeva (Lomonosov Moscow State Univ.). Zhur. Anal. Khim. 15, 117-18(1960) Jan.-Feb. (In Russian)

Two methods are described for the determination of beryllium by its precipitation with 2.2-dimethylhexanedione-3.5 and 3-acetylhexanone-2. (auth)

## Radiation Chemistry

**10483**

RADIATION EFFECT ON REACTIONS OF NITROGEN DISSOLVED IN WATER. M. T. Dmitriev and S. Ya. Pshezhetskii. Atomnaya Energ. 8, 59-62(1960) Jan. (In Russian)

Under the action of ionizing radiation, dissolved nitrogen oxidizes nitrate, nitrite, and ammonia. The yield of each of these products depends upon the composition of the dissolved gas and the amount of energy absorbed. The yield per 100 e.v. in absorbed energy is 0.09 to 0.18 atoms at 1 atm. pressure and 1 to 1.4 atoms at 150 atm. (R.V.J.)

**10484**

DOUBLE BONDS IN POLYETHYLENE BOMBARDED BY FAST ELECTRONS. N. A. Slovokhotova, A. T. Koritskii, and N. J. Buben (Karpov Inst. of Physics and Tech., USSR). Doklady Akad. Nauk S.S.S.R. 129, 1347-8(1959) Dec. 21. (In Russian)

The formation of double bonds in polyethylene bombarded by fast electrons in a nitrogen medium at −196 to 50°C was studied by infrared spectroscopy. (R.V.J.)

**10485**

EFFECTS OF UV AND γ RADIATION ON ACRIDINE SOLUTIONS. V. MECHANISM OF PHOTO-CHEMICAL REACTIONS OF ACRIDINE IN HYDROGENOUS SOLVENTS. Arlette Kellmann (Laboratoire de Chimie Physique, Paris.) J. chim. phys. 57, 1-4(1960) Jan. (In French)

It is shown that the product formed by ultraviolet irradiation of acridine in alcohol, hexane, and benzene is diacridine. (tr-auth)

**10486**

RADIOCHEMICAL POLYMERIZATION OF STYRENE IN THE SOLID STATE. Adolphe Chapiro and Vivian Stannett (Centre National de la Recherche Scientifique, Bellevue, France). J. chim. phys. 57, 35-7(1960) Jan. (In French)

The polymerization of styrene at −78°C initiated by 45-kv x rays was studied. The rate of this reaction does not change in the presence of diphenylpicrylhydrazyl. It increases noticeably in the presence of benzoquinone. The reaction is followed by an important post-polymerization at the instant of re-heating the irradiated monomer and before complete melting. The results are interpreted as indicating that styrene polymerizes in the solid state by an anionic mechanism and that this reaction is sensitized by compounds with a strong electronic affinity. (tr-auth)

**10487**

REDUCTION OF THALLIC IONS IN ACID SOLUTIONS BY ALPHA AND GAMMA RAYS. EFFECTS OF THALLOUS ION CONCENTRATION. M. Lefort and X. Tarrago (Laboratoire de Physique Nucléaire, Orsay, France). J. chim. phys. 57, 38-46(1960) Jan. (In French)

The reduction of thallic ions in aqueous solutions of sulfuric acid by gamma and alpha rays takes place with yields of 2.36 and 3.10 equivalents per 100 kev, respectively. The very slow reaction of oxygenated water with thallic ions is catalyzed by the radiation. It is shown that divalent Tl ions are one step in the reduction process. Their formation by radiation initiates a chain reduction reaction by $H_2O_2$. The concentration of $Tl^+$ has an effect on the reduction yield. Systematic studies of it show how the reaction $OH + Tl^+ \rightarrow Tl^{2+} + OH^-$ competes with the reaction which produces oxygenated water ($OH + OH \rightarrow H_2O_2$) in regions of high free-radical concentration located near the paths of ionizing particles. The importance of the "intrajectory" reaction ($OH + H_2O_2 \rightarrow HO_2 + H_2O$) is discussed. It is concluded that for 5.3-Mev alpha rays the yields are: $G_H = 0.58$, $G_{H_2} = 1.60$, $G_{OH} = 0.40$, $G_{HO_2} = 0.20$, and $G_{H_2O_2} = 1.38$. The decomposition yield of water would then be 3.6 ± 0.1. (tr-auth)

**10488**

RADIOCHEMICAL YIELDS OF FREE RADICALS IN BINARY MIXTURES OF CARBON TETRACHLORIDE WITH SEVERAL ORGANIC ESTERS. Adolphe Chapiro, Étienne Goethals, and Shulamith Munk (Centre National de la Recherche Scientifique, Bellevue, France). J. chim. phys. 57, 47-52(1960) Jan. (In French)

A study was made of the radiochemical yields of free radicals $G_R$ in mixtures of $CCl_4$ with methyl acrylate and vinyl acetate. The $G_R$ values were deduced both from radiochemical polymerization kinetics of the two monomers in $CCl_4$ and from the rate of consumption of DPPH (diphenylpicrylhydrazyl) in binary mixtures of various compositions. In the $CCl_4$—methylacrylate, the two methods showed a strong sensitization for the production of free radicals. On the other hand, in the $CCl_4$—vinyl acetate mixtures a de-activation was found by the polymerization method and a slight sensitization by the DPPH method. These results are interpreted as indicating that polymerization of the vinyl acetate was retarded by the formation of less-reactive $CCl_3$ radicals. The agreement of these results with those of other workers is discussed. (tr-auth)

**10489**

REDUCTION OF CERIC IONS UNDER α RADIATION. EFFECTS OF FORMIC ACID. Maria Do Carmo Anta and Maria Helena Mariano (Comissão de Estudos da Energia Nuclear, Lisbon). J. chim. phys. 57, 59-62(1960) Jan. (In French)

A study was made of the effects of $Po^{210}$ α particles on sulfuric acid solutions of Ce containing formic acid. In 0.8N $H_2SO_4$ and in the absence of formic acid, the reduction yield of $Ce^{4+}$ ions is $G(Ce^{3+})$ ± 0.06 with respect to $G(Fe^{3+}) = 5.2$; by adding formic acid in sufficient quantities, it becomes $G(Ce^{3+})$ (HCOOH) = 4.04 ± 0.03. Starting with the interpretation of the results obtained, the radical and molecular yield values were calculated for radiolysis of water by 5.3-Mev α particles. (tr-auth)

**10490**

γ-RADIATION-INDUCED POLYMERIZATION OF ETHENESULFONAMIDE. Richard H. Wiley and David E. Gensheimer (Univ. of Louisville, Ky.). J. Polymer Sci. 42, 119-23(1960) Jan.

The $Co^{60}$ γ-radiation-induced polymerization of ethenesulfonamide is extremely rapid. The monomer is converted to polymer at the rate of 75%/hr at 4200 r/min as compared to rates of 1−17%/hr for other monomers under similar conditions. The polymer shows the viscosity characteristics of a polyelectrolyte (intrinisic viscosity of 0.5 at 0.125% in dimethylformamide) and is estimated to have molecular weight of $\overline{M}_n$ 12,000 and $M_w$ 50,000 from a preliminary evaluation of viscosity, osmotic, and light scattering data. $G_i$ values of 170 to 40 are indicated for the polymerization on the basis of estimated molecular weights of 12,000 to 50,000. (auth)

**10491**

THE MECHANISMS OF RADIATION-INDUCED CHANGES IN VINYL POLYMERS. Audrey Todd (The University, Birmingham, Eng.). J. Polymer Sci. 42, 223-47(1960) Jan.

An investigation was made to discover why some polymers degrade while others predominantly crosslink on exposure to high-energy radiation. All the work was carried out on pure vinyl polymers prepared under controlled conditions, and the irradiations were conducted in vacuo. The volatile irradiation products were analyzed by mass spectrography, and the polymer residues were examined by solubility tests, viscosity measurements, and radioactive assay of $C^{14}$-labeled polymers. The results confirmed that vinyl polymers containing a quaternary carbon atom degraded while the rest became crosslinked. Polymethyl methacrylate underwent random main-chain scission with the elimination of rather less than one $\cdot COOCH_3$ side group for each main-chain fracture. Some of the polymers which crosslinked lost side groups but this was not related directly to the crosslinking reaction. Free radical mechanisms are proposed to explain the occurrence and the observed features of the radiation-induced degradation and crosslinking reactions. (auth)

**10492**

IMPROVEMENT OF PLASTICS BY IRRADIATION. Alphonse Lamm (Centre d'Etudes Nucléaires, Saclay, France). Kerntechnik 2, 41-6(1960) Feb. (In German)

The improvement of plastics by irradiation depends on various mechanisms which are briefly described. Reticulation and polymerization, which are ascribed principally to the formation of radicals and subsequent chain reactions, are discussed. As concrete examples, polyethylene reticulation with its advantages (for example, improvement of the heat resistance), rubber vulcanization with its problems (attainment of a better yield by addition of sensitizers), and grafting polymerization with its various varieties (irradiation of a polymeride in the presence of a monomer, preliminary irradiation of the polymer, and grafting by immersion in the monomer and heating) are described. The problem of economy in the application of energetic beams in the area of plastics is reviewed. (tr-auth)

**10493**

THE PROBLEMS OF RADIATION CHEMISTRY IN AQUEOUS SOLUTIONS. S. Minc and L. Stolarczyk (Instytut Badań Jądrowych PAN, Warsaw). Nukleonika 4, 473-85 (1960). (In Polish)

Problems of radiation chemistry in aqueous solutions are discussed. The specific problems discussed include: primary processes, the radial diffusion theory, radial and molecular yields, the radial species formed in water, chemical reactions between radicals and solute molecules, and reactions between excited molecules and hot radicals. The problems of chemical dosimetry and the possibilities of practical uses of radiation chemistry are considered. (C.J.G.)

**10494**

ON THE RADIOLYTIC REDUCTION OF AQUEOUS SODIUM NITRATE SOLUTIONS SATURATED WITH HYDROGEN. V. A. Sharpatyi and V. D. Orekhov (Karpov Inst. of Physics and Chemistry, Moscow). Nukleonika 4, 487-9(1960). (In Russian)

The radiolytic reduction of the nitrate-ions in hydrogen and nitrogen saturated aqueous solutions was investigated over the pH range 1 to 14. It was found that under these conditions the nitrite yields are independent of the dissolved gas ($N_2$ or $H_2$). From these results it is suggested that the reaction $H_2 + OH \rightarrow H + H_2O$ does not have a great effect on the process studied. (auth)

**10495**

RADIATION KINETICS IN ANTHRACENE-SILICONE MIXTURES. A. Charlesby (Royal Military Coll. of Science, Shrivenham, Berks, Eng.) and D. G. Lloyd (T. I. Research Labs., Cambridge, Eng.). Proc. Roy. Soc. (London), A254, 343-57(1960) Feb. 23.

The yield of radicals produced in radiation-induced reactions in simple organic compounds was studied by incorporating low concentrations of an additive capable of acting as a trap for the radicals produced. Previous work is extended on compounds of low molecular weight into the field of polymers. The removal of anthracene in polydimethyl siloxane fluids is studied as a function of concentration, dose, and intensity. The results obtained show a fundamental difference from those previously found in anthracene-cyclohexane solutions in that there is little dependence on radiation intensity. The earlier theory, according to which there is competition between radical-radical and radical-anthracene combination is not tenable in the present system. An alternative theory according to which reactions of active centers occur, either with the neutral environment or with anthracene molecules, is consistent with the observed data. Values for the reaction constants are derived. (auth)

**10496**

THE RADIOLYSIS OF LIQUID METHYL ACETATE WITH $Co^{60}$ GAMMA RADIATION. R. W. Hummel (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Trans. Faraday Soc. 56, 234-45(1960) Feb.

The irradiation of air-free liquid methyl acetate at ambient temperatures yields six gaseous and seventeen liquid products. A number of radical intermediates are proposed to account for the observations. All the bonds in methyl acetate except the carbonyl double bond appeared to be broken. The effects of "radical scavengers" (diphenylpicrylhydrazyl, diphenylpicrylhydrazine, and benzoquinone) on gas yields are examined. (auth)

**10497**

ON THE CARBONIUM MECHANISM OF POLYMERIZATION BY GAMMA-RAYS. A. D. Abkin, A. D. Sheinker, and L. P. Mezhirova. Zhur. Fiz. Khim. 33, 2636(1959) Nov. (In Russian)

Data on gamma-induced (150 r/sec) polymerization of acrylonitrile and styrene in various solvents at −78°C are tabulated. (R.V.J.)

**10498**

IMPROVEMENTS IN OR RELATING TO METHODS OF POLYMERIZATION USING GAMMA RADIATION. (to Societe Anonyme des Manufactures des Glaces et Produits Chemiques de Saint-Gobain, Chauny & Cirey). British Patent 830,515. Mar. 16, 1960.

A radiation polymerization technique is described which avoids modification of the polymer after its formation. The polymer is separated from the unpolymerized composition at intervals thus preventing further exposure. (T.R.H.)

## Radiochemistry

**10499** NSA-NS-3004

National Research Council. Committee on Nuclear Science.

THE RADIOCHEMISTRY OF THORIUM. E. K. Hyde.

(Univ. of Calif. Lawrence Radiation Lab., Berkeley). Jan. 1960. 73p. OTS.

A review of the nuclear and chemical features of particular interest to the radiochemist, a discussion of problems of dissolution of a sample and counting techniques, and a collection of radiochemical procedures for the element as found in the literature are included. (W.L.H.)

**10500** CN-tr-1

RIASSUNTI DELLE COMUNICAZIONI SULLA RADIOCHIMICA E LA CHIMICA DEGLI ISOTOPI PRESENTATE ALL'VIII CONGRESSO MENDELEEV DI CHIMICA GENERALE ED APPLICATA TENUTO A MOSCA NEL MARZO 1959. (Summaries of the Papers on Radiochemistry and the Chemistry of Isotopes Presented at the VIII Mendeleev Congress of General and Applied Chemistry Held at Moscow in March 1959). Translated into Italian by S. Santoli. 40p.

Summaries of thirty papers are presented on the chemistry of uranium and transuranium elements, the chemistry of other radioisotopes, low concentration chemistry, hot atom chemistry, isotopic exchange and general studies on kinetics, stable isotopes, and mass spectrometry. (C.J.G.)

## Raw Materials and Feed Materials

**10501** M-4559

Du Pont de Nemours (E. I.) & Co. Engineering Dept., Wilmington, Del.

FINAL REPORT ON BPX-1, CRUDE URANIUM PRODUCTION; EVALUATION OF ALTERNATE HEATING METHODS. C. G. Lenk and W. A. Bours. Nov. 15, 1944. Decl. Feb. 16, 1960. 69p. OTS.

A comparative evaluation was made of electric induction and gas-fired furnaces when employed for heating to the reaction temperature the vessels used in the reduction of UF$_4$ to crude U. It was found that the original electric induction furnaces installed gave lower reduction yields than an experimental gas-fired furnace. It was also found that raw materials quality and operating techniques had a major effect upon yield. Improvements were made in the construction of the electric induction furnaces until their yield performance was as good as that of the gas furnace, given good quality raw materials. The estimated maintenance and power costs for operating an electric induction furnace unit were found to be higher than for a gas furnace. (auth)

**10502** WIN-112

National Lead Co., Inc. Winchester Lab., Winchester, Mass.

JANUARY 1960—SUMMARY REPORT ON: I. THE CONTROL OF RADIUM AND THORIUM IN THE URANIUM MILLING INDUSTRY. II. RADIUM-226 ANALYSIS PRINCIPLES, INTERFERENCE AND PRACTICE. III. CURRENT WINCHESTER LABORATORY PROJECTS. Feb. 1, 1960. 101p. Contract AT(49-6)-924. OTS.

This report presents the present (January 1960) status of certain aspects of the radioactive pollution problems associated with uranium milling. Specifically, the physical and chemical behavior of radium and thorium in mill systems, the treatment of plant wastes, and the analytical chemistry of radium, are considered. The current research program of the Winchester Laboratory is also presented. The acid leaching process dissolves about 5% of the radium and 50% of the thorium from uranium ores, the rest remaining in the tailings. In alkaline leaching, 2 to 3% of the radium but practically no thorium goes into solution. In untreated effluents from acid leach mills, the concentration of radium-226 will be substantially higher than the permissible levels for discharge, and the concentration of thorium-230 may also be significantly high. Proper treatment of the wastes, including neutralization and barite treatment, reduce the concentrations of these isotopes to acceptable levels. Effluents from alkaline leach processes, which contain some radium but no appreciable thorium, may be treated with copperas, followed by barite if required. The analysis of effluents and similar systems is complicated by the presence of the thorium members of the decay series. Although chemical separation steps give a radium fraction free of thorium, ingrowth of radium from a thorium parent in the period between sampling and analysis cannot be ignored. Because of the half-lives involved, the ingrowth of radium-223 from thorium-227 is particularly important. The present Winchester Laboratory program is devoted principally to the basic chemistry of radium and thorium, their behavior in plant wastes, and improvement of analytical techniques for these elements. (auth)

**10503**

FLUID BED CONVERSION OF UO$_3$ TO UF$_4$. R. P. Levey, Jr., H. M. Heidt, and Paul E. Trent (Union Carbide Nuclear Co.; Y-12 Plant, Oak Ridge, Tenn.) and A. de la Garza and S. C. Jacobs (Oak Ridge Gaseous Diffusion Plant, Tenn.). Chem. Eng. Progr. 56, No. 3, 43-8(1960) Mar.

The design and performance of a tapered fluid bed reactor for reduction and hydrofluorination of UO$_3$ to UF$_4$ are discussed. Accessory pilot plant equipment and the rate determining processes are discussed. (C.J.G.)

**10504**

THE FUTURE FOR CHEAP HEAVY WATER. Frank T. Barr and William P. Drews (Esso Research and Engineering Co., Linden, N. J.). Chem. Eng. Progr. 56, No. 3, 49-56(1960) Mar.

A survey of ninety eight processes for the production of heavy water was made. Eight processes having economic advantages over the remaining ninety are described. These processes include: hydrogen—water exchange; hydrogen—water—hydrazine; phosphine—water; hydrogen iodide—water; reversible electrolysis of water; direct electrolysis of deuterium; and char adsorption of water. Equations for the calculation of the dry and wet cross section are given. (C.J.G.)

**10505**

URANIUM TETRAFLUORIDE MANUFACTURE WITH FLUIDIZED SOLID TECHNIQUES. E. Hawthorn (United Kingdom Atomic Energy Authority, Springfields, Lancs, Eng.). Nuclear Power 5, No. 47, 120-3(1960) Mar.

The preparation of UF$_4$ using fluidized solids reactors is described. After nitration, the uranyl nitrate solution is converted to uranium trioxide by thermal decomposition. The trioxide is reduced to dioxide by fluidization with hydrogen and converted to tetrafluoride by the action of hydrofluoric acid. A quadrupole effect evaporator which is associated with the fluidized solids reactor is used to remove most of the water from the uranyl nitrate solution. Descriptions of the reactor and a hydrofluoric acid recovery plant are given. (C.J.G.)

## Separation Processes

**10506** AECU-4610

Michigan. Univ., Ann Arbor.

RADIOCHEMICAL SEPARATION OF CADMIUM AND THE APPLICATION OF VACUUM DISTILLATION OF METALS TO RADIOCHEMICAL SEPARATIONS. James R. DeVoe.

Dec. 1959. 100p. Project No. 7. Contract AT(11-1)-70. OTS.

Research was conducted to evaluate and develop radiochemical separation procedures for the elements. Radioactive tracer techniques were used to measure the degree of separation of the desired element from a large number of elements, which were selected on the basis of their being representative of the groupings in the periodic table. An evaluation of the radiochemical separations of Cd was made by studying the separation by solvent extraction with dithizone in basic media, by ion exchange in hydrochloric acid solution, and by two precipitation methods. The separation by dithizone and ion exchange resulted in a Cd yield of 78% with decontamination factors of $10^3$ for twenty elements. Although the organic precipitant appeared to be selective for Cd, a poor separation was obtained; however separation of Cd with a yield of 78% and decontamination factors of $10^3$ for fifteen elements was obtained with Reinecke salt. In order to determine the feasibility of radiochemical separations by vacuum distillation of the elemental state, an exploratory evaluation of the method was made. The systems Cd-Zn, and Cd-Ag were studied to measure the degree of Cd separation that could be obtained by distillation from various atom ratios of Cd to Zn or Ag. The separation that was observed with these metal systems was compared with the theoretical degree of separation when it was assumed that an ideal solution existed. The discrepancy between theory and experiment is discussed. Separation procedures which were evaluated include the separation of trace amounts of Hg by chemical reduction onto a Cu foil with subsequent distillation of the Hg, and by electrolysis of Cd (1 mg.) onto Cu foil followed by distillation of the Cd. A useful application of the vacuum distillation technique was found in the separation of a volatile carrier free daughter from a macro amount of a less volatile parent metal, such as the separation of $In^{113m}$ from neutron irradiated Sn. From this type of system, vacuum distillation can provide a method for preparing very thin high specific activity counting sources. (auth)

**10507** CEA-1212
France. Commissariat à l'Énergie Atomique, Paris. UTILISATION DU RECUL POUR LA SEPARATION DES PRODUITS DE FISSION DE L'URANIUM. (The Use of Recoil for the Separation of Uranium Fission Products). R. Henry and C. Herczeg. 1959. 13p.

The recoil distance of fission fragments in $U_3O_8$ is about 8 microns. By using highly diluted suspensions of uranium oxide particles having dimensions much smaller than this figure (mean diameter 0.5 micron), the readsorption of fission products on uranium oxide was studied. Separation results were studied as a function of the nature of the irradiation medium (solid or liquid) and the separation medium, of particle size and of concentration of particles in the dispersing medium. Decay curves can be used to discriminate between $Np^{239}$ and mixed fission products. Most of the $Np^{239}$ is found in the $U_3O_8$ particles. The location of fission products in solid dispersing media was determined, fission products being found always inside the dispersing medium particles. The results obtained can be applied to the rapid separation of short-lived fission products from a uranium-free starting material. (auth)

**10508** CEA-1214
France. Commissariat à l'Énergie Atomique, Paris. TRAITEMENT INDUSTRIEL DE SOLUTIONS DE PRODUITS DE FISSION. SEPARATION DU CESIUM 137. (Industrial Treatment of Solutions of Fission Products. Separation of Cesium-137). C. Fisher and A. Raggenbass. 1959. 14p.

Two types of chemical treatment can be considered for the manufacture of solid sources for industrial uses from fission product solutions remaining after plutonium extraction. One involves concentration of the solution and preparation of solid sources from the bulk material, without separation, and the other is separation of one or several fission products from which the sources are made. Examination of the radiochemical composition of the mixture of fission products that will be available from the Marcoule reactors (G1, G2, and G3) shows that cesium-137 accounts for 30 per cent of the $\gamma$ energy available immediately after the plutonium separation, 70 per cent two years later and 100 per cent after five years. There is practically no advantage in making sources from bulk fission products, since the separation of cesium-137 is no more complicated and yet it results in a material with more potential uses. The separation of cesium-137 by a method based on the standard phosphotungstate precipitation method has been considered. Previously, the precipitated cesium phosphotungstate was dissolved and cesium was recovered from the solution by cation-exchange or by removal of phosphate and tungstate ions by anion-exchange. A study has now been made, of the metathesis of cesium phosphotungstate to barium phosphate and tungstate by the action of barium hydroxide, the cesium being obtained in solution as the hydroxide. The advantages of this new procedure are: greater decontamination of cesium-137 without further purification, possibility of direct transformation to cesium sulfate, general simplification of the procedure and, consequently, of the equipment. (auth)

**10509** CF-59-1-74
Oak Ridge National Lab., Tenn. CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] JANUARY 1959. J. C. Bresee, P. A. Haas, R. W. Horton, C. D. Watson, and M. E. Whatley. Apr. 30, 1959. 72p. OTS.

Two alternate systems, acetic acid-nickel and acetic acid-cobalt, were examined for possible replacement of the corrosion system: ferric chloride-nickel which is being used in the current transpiration corrosion protection studies. Two Fluorox fluidized bed runs were made, of 9 and 58 hr duration, in which dry air and oxygen were used as oxidizing and fluidizing gases. Tests of the hydroclone classification of thoria indicated that more than 95% of the +0.5 micron particles can be removed from a sample if 50% recovery of the −0.5 micron particles is acceptable. Fluidized bed denitration of ThNT did not produce large dense $ThO_2$ particles, but flame denitration of mixed thorium-uranium-aluminum nitrates produced spherical particles. Three alternate batch Darex flowsheets gave chloride removal to less than 350 ppm with 61% nitric acid feed, while dissolution studies of APPR fuel elements showed that complete dissolution of braze metal in aqua regia may be difficult. Leaching studies of unirradiated $UO_2$ pellets showed that the most important variable effecting dissolution rate was the total nitrate content of the dissolvent. Delivery of the SRE decanning equipment was scheduled for April 1, 1959. Temperature increases in cylinders of solid radioactive waste were calculated for APPR fuel processing using a Darex flowsheet and cooling times ranging from 1 to 8 yr. (auth)

**10510** CF-59-2-45
Oak Ridge National Lab., Tenn. CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] FEBRUARY 1959. J. C. Bresee, P. A. Haas, C. D. Watson, M. E. Whatley, and R. W. Horton. June 11, 1959. 87p. OTS.

A gamma scintillation spectrometer was used to measure diffusivity of uranyl nitrate in water during preliminary capillary experiments. During Fluorox run FBR-22, 90.4% of the theoretical amount of $UF_6$ formed was collected in cold traps and chemical traps. Toroid tests of flame calcined mixed Th-U oxide showed low corrosion rates, small changes in particle size and a low solubilization of uranium, while denitration of uranyl nitrate in a fluidized bed resulted in particle growth with uniform layers of uranium oxide. A half-time of 30 min for uranium anion exchange was measured in differential bed studies of uranium sorption on Dowex 21K. The Darex Reference flowsheet operation resulted in chloride removal to less than 50 ppm in solvent extraction feed from APPR head-end treatment. Unirradiated prototype Consolidated Edison pins were dejacketed with 6 $\underline{M}$ $H_2SO_4$ with uranium losses to the dejacketing solution of approximately 0.2%. An optimum procedure was developed for clarifying large batches of solvent extraction feed by sand bed filtration. Sheared sections of stainless steel clad $UO_2$ were completely leached in one-half the time required for equal lengths of stainless tubes containing uncrushed pellets. Abrasive disc wheel to metal removal ratios were measured at cutting rates from 10 to 60 in./min. Dissolution of Zircaloy-2 dummy fuel elements in an INOR-8 dissolver with the NaF-LiF salt system resulted in vessel wall corrosion rates of 1-2 mils/run (approximately 8 hr of HF exposure). At a heat generation rate of 60 Btu/hr/gal of solid wastes, the maximum temperature rise in a 0.75 ft radius infinite cylinder ($k = 0.1$ Btu/hr sq ft °F) was 1270°F in soil, 1150°F in rock, and 1020°F in salt. (For preceding period see CF-59-1-74.) (auth)

**10511** CF-59-3-61
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] MARCH 1959. J. C. Bresee, P. A. Haas, R. W. Horton, C. D. Watson, and M. E. Whatley. June 26, 1959. 69p. OTS.

In a preliminary experiment, the integral diffusivity of 1 $\underline{M}$ $FeCl_3$ solution varied uniformly with the fraction diffused: from $0.3 \times 10^{-6}$ cm$^2$/sec for 10 per cent diffused to $0.8 \times 10^{-6}$ for 30 per cent diffused. A short Fluorox run made with crude $UF_4$ in the 4-in. fluidized bed showed that $UF_6$ could be produced from the impure feed. Denitration of $Th(NO_3)_4$ solutions on fluidized or mechanically agitated beds of $ThO_2$ or sand gave fine $ThO_2$ particles for all conditions tested. The rate of sorption of uranium into 40 micron Dowex 21K resin particles from a 0.0042 $\underline{M}$ uranyl sulfate solution was studied by measuring the uranium loading on individual beads as a function of time. Chloride concentrations of 28 to 51 ppm were produced in the solvent extraction feeds during five feed adjustment runs made with the Darex Reference flowsheet. Decladding of SS-clad $ThO_2-UO_2$ pellets with a continuous feed of 6 $\underline{M}$ $H_2SO_4$ gave essentially identical results as batch decladding. When a Mark I prototype assembly was sheared into 0.75-in. lengths with a "plane of contact" blade in the 126-ton Manco shear, 22.2 g of metal fines (304L stainless steel) 1680 microns or less in size was produced with 36.5% less than 150 micron. $UO_2$ was leached from sheared stainless steel cladding, 0.4 in. O.D. × 2.75–0.5 in. long, with 10 $\underline{M}$ $HNO_3$ at an average rate of 0.009 to 0.067 g/min/g of initial $UO_2$, respectively, and at initial rates of 0.052 to 0.29 g/min/g. After four runs at approximately 700°C with NaF-LiF melts (initial concentration: 43 mol per cent NaF, final concentration: approximately 12 mol per cent $ZrF_4$), average corrosion rates varied from 0.25 mils/hr maximum (at the interface) to 0.12 mils/hr minimum (in the vapor space). Heat transfer calculations on the storage of cylindrical containers of waste showed that the allowable specific heat generation in the waste can be increased by 20 to 30% by storage of the waste in air cooled vaults rather than burial with a 1-in. air gap between the container and the ground media. (For preceding period see CF-59-2-45.) (auth)

**10512** CF-59-4-47
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] APRIL 1959. J. C. Bresee, P. A. Haas, R. W. Horton, C. D. Watson, and M. E. Whatley. July 21, 1959. 94p. OTS.

A concentration cell electrode was installed in a fritted glass surface and was used to measure the surface KCl concentration while water was being transpired through the surface into a mixed tank of 0.1 $\underline{M}$ KCl. The results from the first Fluorox run made with crude $UF_4$ showed that 85.3% of the theoretical amount of $UF_6$ was accounted for, with 17.9% being collected in cold traps and the remainder being consumed in various side reactions. Installation was completed of apparatus to study the electrolytic removal of nickel on an engineering scale from concentrated HRT fuel solution. An extremely low yield stress of 0.02 lb/sq ft was measured for a thoria-urania slurry containing 2.5 wt.% $Al_2O_3$ and spherical particles of 1.7 micron mean diameter. Preliminary data on the rate of uranium sorption on Dowex 21K from sulfate solutions were correlated with a simple spherical diffusion model. Laboratory scale studies to determine the effect of reflux time, $HNO_3$ concentration, and air sparge on chloride removal from APPR-type Darex dissolver product showed that an air sparge is definitely beneficial in chloride removal. Preliminary cyclic cleaning tests showed that boiling 25% caustic solution was adequate for cleaning type F (20 micron) porous metal filter elements fouled in the absence of filter aid with siliceous sludge from Darex solvent extraction feed solutions. Sections of unirradiated stainless steel-clad $UO_2$, sheared into lengths of $\frac{1}{2}$ in., 1 in., 2 in., and $2\frac{3}{4}$ in., were leached free of $UO_2$ with 10 $\underline{M}$ $HNO_3$ in 30, 45, 60, and 75 min, respectively. The abrasive blade cost for the removal of inert end adapters from selected reactor assemblies ranges from $0.12 for the Gas-Cooled Reactor to $1.19 for Consolidated Edison. A zirconium dissolution was carried to completion at 600°C in a NaF-LiF salt mixture containing initially 23 mol per cent $ZrF_4$ at an average rate of 1.3 mg/(cm$^2$)(min) with an HF feed rate of 2 lb/hr. The thermal conductivity and thermal diffusivity at the center of an 8-in. diameter cake of Darex waste calcined at about 900°C were determined as a function of temperature. (For preceding period see CF-59-3-61.) (auth)

**10513** CF-59-5-47
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] MAY 1959. J. C. Bresee, P. A. Haas, R. W. Horton, C. D. Watson, and M. E. Whatley. Aug. 25, 1959. 103p. OTS.

The measured diffusivity of uranyl nitrate in water at 25°C was $0.7 \times 10^{-6}$ cm$^2$/sec with about 40% average deviation. A program was started to develop nonnuclear uses for depleted uranium. Two continuous DRUHM reaction runs were terminated due to erratic operation of the sodium metering system. In the second Fluorox run with crude $UF_4$ which lasted for 29 hr, a total material balance of 94.8% was obtained and 17.9% of the theoretical amount of $UF_6$ was collected in cold traps and chemical traps. Room temperature flow rate-pressure drop calibrations of a multiclone (thirteen 0.60-in. diam. hydroclones in parallel) for installation with the HRT replacement circulating pump were completed. Mixed oxides of U : Th = 0.08 : 1 and 1, 2½, 5, and 10 wt.% $Al_2O_3$ prepared by flame denitration all have low yield stresses of 0.02 to 0.05 lb/sq ft compared to 0.2 to 1.0 lb/sq ft for normal Th–U or Th oxides of 1.5 to 2.5 micron mean diameter. The rates of uranium anion exchange from solutions containing between 0.025 and 0.20 M sulfate were measured and apparent uranium diffusion coefficients between $1.2 \times 10^{-7}$ $cm^2$/sec and $1.6 \times 10^{-7}$ $cm^2$/sec were calculated. In bench scale studies, the Darex reference flowsheet was successfully applied to stainless steel-clad $UO_2$ fuels (Yankee Atomic) and to aluminum-uranium foreign reactor fuels. The corrosion of titanium A-55 was measured in the vapor and liquid phases of a modified boiling Thorex dissolvent (13 M $HNO_3$, 0.04 M $F^-$, 0.1 M $H_3BO_3$) containing 0.0, 0.5, and 1.0 M thorium from dissolved Consolidated Edison pellets and the maximum corrosion rate was 0.6 mils/month. Siliceous filter cakes resulting from the filtration of Darex solvent extraction feed solutions through porous metal filter elements were easily washed to a uranium loss of 0.1% in the discarded cake. A run with an acid-deficient Darex-Redox feed containing soluble silica resulted in uranium losses higher by a factor of 20 than those previously obtained in the same column with a standard Redox feed. Batch leaching of sheared pieces, ½ in. to 5 in. long, of PWR reject $UO_2$ pellets clad with stainless steel, 0.40 in. o.d. with 0.10 in. wall, in boiling 10 M $HNO_3$ (173% excess) was completed in 70 to 245 min. Dissolution test runs of Zr-2 in fused salt made at approximately 700°C under identical conditions except for HF feed rate resulted in dissolution rates of 1.87 and 2.68 mg/min-sq cm for 2.5 and 6.0 lb/hr HF feed rate, respectively. Purex and TBP-25 evaporated wastes were calcined at 900 to 1000°C resulting in solid wastes which had densities of 0.77 to 0.83 and 0.40 to 0.45 g/cc, respectively. (For preceding period see CF-59-4-47.) (auth)

**10514** CF-59-6-63
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] JUNE 1959. J. C. Bresee, P. A. Haas, C. D. Watson, M. E. Whatley, and R. W. Horton. Sept. 4, 1959. 64p. OTS.

The addition of a surface active agent to an aqueous-organic interface produced a resistance to mass transfer equivalent to slightly more than 1 cm of water. Five semi-continuous Druhm runs were made with ½-in. thick MgO liners and terminated due to either failures of the $UF_6$ nozzle or a top gasket leak. In preliminary scale-up tests of the flame calcination equipment, a maximum feed rate equivalent to 720 g oxides/hr was achieved using a 3-in. i.d. magnesia reflector with an outside wall temperature of 1500°C. In a test with a light water feed, 99% Cu, 25% Ni, and 0% Mn were removed from a $UO_2SO_4$ solution by electrolysis with a mercury cathode in 7800 ampere hours. The effect of varying the total sulfate concentration on the kinetics of the absorption of uranyl sulfate on Dowex 21K at a uranium concentration of 0.005779 M and a sulfuric acid concentration of 0.020 M was studied in a series of runs using a stirred bath containing enriched uranium. Chloride was removed to 64 ppm in Yankee Atomic and to 70 ppm in APPR solvent extraction feeds using a reference Darex flowsheet with air sparging during a two hour reflux period in the 10-in. prototype titanium feed adjustment tank. Soluble uranium contained in a filter cake deposited onto a 20 micron porous metallic star shaped filter from approximately twenty-one liters of Darex solvent extraction feed solution was recovered to 99.9% by a single 5 liter water wash of the cake. An experimental Redox solvent extraction program was completed. Shear blade evaluation tests have begun at Birdsboro and Clearing under subcontract and will be completed by July 1. Tests were made on the separation of water associated with sheared material through porous bottom baskets as would be required in wet shearing concepts. Consolidated Edison prototype elements assembled with ductile Coast Metals 50 brazing metal could not be disassembled with the impact wedge previously successfully used to disassemble elements made up with brittle Nicrobraze 50. A reactor and condenser system designed to sublime $ZrF_4$ from the hydrofluorinator to a separate receiver at temperatures above 902°C was operated at condensation rates between 150 and 500 g per hour of $ZrF_4$. The thermal conductivities of granular Darex, Purex, and TBP-25 calcined solids were in the range of 0.043 to 0.097 Btu/hr sq ft (°F/ft) at room temperature. (For preceding period see CF-59-5-47.) (auth)

**10515** CF-59-7-58
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] JULY 1959. J. C. Bresee, P. A. Haas, R. W. Horton, C. D. Watson, and M. E. Whatley. Oct. 9, 1959. 116p. OTS.

A Lucite model of a multi-stage countercurrent hydroclone solvent extraction apparatus has been constructed and tested with Amsco-water. The diffusivity of Cs 134 tracer in aqueous chloride solution was measured to check the performance of the capillary diffusivity measuring system. The experimental data from four Druhm runs showed that ⅛-in. thick graphite liners are usable for reactor temperatures above the boiling point of sodium. Development of electrolysis procedures to remove nickel from solutions simulating concentrated HRT fuel solutions (80 g U/liter, 15 g Cu/liter, 1.0 M $SO_4^=$) was completed by test runs with both $H_2O$ and $D_2O$ solvent. Flame denitration of $Th(NO_3)_4-Al(NO_3)_3$ in $CH_3OH$ solutions with reflector temperatures of 1500°C gave 95 wt.% $ThO_2$–5 wt.% $Al_2O_3$ particles with a high degree of sphericity. The self-diffusion coefficient of sulfate ions in Dowex 21K beads in equilibrium with a 1 M $Na_2SO_4$ solution was measured using 1200$\mu$ beads and was $1.2 \times 10^{-6}$ sq cm/sec. Boiling 30% caustic was again shown to remove effectively siliceous fouling accumulated in filter pores during filtration of Darex (APPR) feed slurries on porous metal filter elements. Shearing of stainless-clad $UO_2$ to expose the $UO_2$ core material for subsequent nitric leaching appeared feasible in shear blade evaluation tests recently completed at Clearing Division of U. S. Industries in Chicago, Illinois, and Birdsboro Machine and Foundry Company in Birdsboro, Pennsylvania. An auxiliary decladding tool for decladding deformed SRE elements cut into 6-in. lengths was designed and a test model successfully demonstrated. A literature survey of reactor coolant and coolant loop contamination and decontamination is being conducted. Two dry hydrofluorination test runs at 950°C were completed, with average reaction rates of 2.25 mg/(min)(sq cm) and 2.38 mg/(min)(sq cm) and corresponding HF utilizations of 44.5% and 70.7%, respectively. During reduction of evaporated Darex waste to solids tests using an 8-in. diam × 48-in. long calcination pot, the flat bottom of ⅛-in. thick pot bulged 1-in. downward due to an unknown internal gas pressure, which was postulated to be from metal nitrates decomposing under a liquid and semisolid seal of wet waste. (For preceding period see CF-59-6-63.) (auth)

**10516** CF-59-8-76
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] AUGUST

1959. J. C. Bresee, P. A. Haas, R. W. Horton, C. D. Watson, and M. E. Whatley. Dec. 31, 1959. 95p. OTS.

The concentration gradients of uranyl ion in aqueous and organic solutions were analyzed by taking a macro photograph of the desired gradient by monochromatic (436 mμ) light transmitted by the solution normal to the gradient in an appropriate diffusion cell. Two Druhm runs were terminated due to malfunction of the sodium metering system and the third run was terminated when the $UF_6$ nozzle ruptured. Calculations of particle temperature versus time relations for the flame denitration-calcination method of preparing metallic oxide from nitrate solutions indicate that the times required for heat transfer are controlled by the rate of radiant heat transfer to particle surfaces instead of by conductive heat transfer within the particles. A completed experimental study indicated that electrolysis in a cell with a mercury cathode and a platinum anode is a practical process for removing nickel from HRT fuel solution. The apparent diffusion coefficient of uranium loading on Dowex 21K was shown to be directly related to the resin size. An explosion of sufficient violence to blow apart the Pyrex pipe dissolver occurred during the fifth Darex dissolution of simulated SRE fuel, probably from a rapid gas phase reaction between hydrogen and oxidizing gases such as $NO_2$. Materials handling flowsheets were completed for (A) decladding, washing, recanning and storing spent SRE uranium fuel slugs and (B) the shearing and leaching of stainless steel clad $UO_2$ and $UO_2$-$ThO_2$ fuels. A literature survey is being conducted dealing with reactor coolant and coolant loop contamination and decontamination. During run R-17 for calcination of evaporated Darex waste, the same as run R-16 which deformed the bottom calcination vessel except that one of the three added pressure probes was vibrated to keep it unplugged, the bottom of the calcination vessel did not deform, and there was no pressure indicated on the pressure probes during the test. (For preceding period see CF-59-7-58.) (auth)

**10517** CF-59-8-142
Oak Ridge National Lab., Tenn.
DEMONSTRATION OF THE ZIRFLEX PROCESS ON IRRADIATED PWR BLANKET FUEL. T. A. Gens, G. A. West, and L. M. Ferris. Aug. 24, 1959. 18p. OTS.

Fifteen PWR blanket fuel specimens, varying in burnup from 80 to 1100 Mwd/T, were declad with boiling 6 M $NH_4F$−1.0 M $NH_4NO_3$ before the $UO_2$ core was dissolved in 10 M $HNO_3$. Uranium and plutonium losses to the decladding solution were less than 0.2% in nearly all runs. While these losses are higher than those obtained in laboratory experiments with unirradiated fuel, they are of the same order of magnitude as those obtained in the testing of the hot cell equipment with unirradiated fuel. In two runs where 9 M HF was used as the decladding reagent, the uranium and plutonium losses averaged 1.0 and 0.4%, respectively. (auth)

**10518** CF-59-9-69
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] SEPTEMBER 1959. J. C. Bresee, J. O. Blomeke, P. A. Haas, R. W. Horton, A. D. Ryon, C. D. Watson, and M. E. Whatley. Jan. 12, 1960. 125p. OTS.

The stacked clone solvent extraction contactor, with a benzoic acid—kerosene—water system, operated with 100% stage efficiencies within the accuracy of the experiment. In the Druhm process, three runs of short duration were made without failures of He-cooled, Inconel $UF_6$ nozzles. Toroid results showed excellent properties of flame-denitrated 90 wt.% $ThO_2$−7 wt.% $UO_2$−2.5 wt.% $Al_2O_3$ product with very low erosion rates for the largely spherical particles and a "normal" corrosion rate for the more irregular product. The self-diffusion coefficient of sulfate ions in uranium loaded 1200μ Dowex 21K resin was $2.3 \pm 1.2 \times 10^{-7}$ sq cm/sec. The ORNL reference Darex flowsheet was modified to provide a procedure for total dissolution processing of Consolidated Edison fuel (SS-clad $UO_2$−$ThO_2$). In comparative scouting tests using a 5-in. diam centrifuge, silica was completely removed from solvent extraction feed solutions of dissolved Foreign Research Reactor fuel, Darex-APPR, and Sulfex-304 SS at the following feed rates and centrifuge fields: 400 cc/min at 800 gees, 300 cc/min at 750 gees, and 100 cc/min at 1000 gees. In preliminary testing of the hydraulic SRE decladder, tube winding, rolling and cutting operations were performed satisfactorily. General corrosion of INOR-8 was not detectable by Vidigage measurements after 74.25 hrs of HF exposure under the Volatility Pilot Plant flowsheet conditions. An experimental calcination run feeding concentrated simulated Darex solvent extraction waste to the 8 × 48-in. calcination vessel terminated in a violent rupturing of the vessel when the off-gas line plugged. (For preceding period see CF-59-8-76.) (auth)

**10519** CF-59-10-77
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] OCTOBER 1959. J. C. Bresee, J. O. Blomeke, P. A. Haas, R. W. Horton, A. D. Ryon, C. D. Watson, and M. E. Whatley. Feb. 3, 1960. 111p. OTS.

The chemical kinetic effect was separated from the diffusional effect in the study of the transpiration protection of porous surfaces from corrosion by using a glass frit surface, which does not corrode, immersed in a stirred bath of dilute KCl and transpiring water through the frit. Consolidated uranium metal was recovered in three of the four final Druhm runs with yields of 3%, 56%, and 90% with a maximum metal purity of 99.98% uranium. A cost estimate was prepared for a 5000 ton ($U_3O_8$)/year Fluorox plant. About 45 lb of flame denitrated thoria prepared as previously reported contains rounded product particles, with about 8 wt.% of over 10μ diam particles. Using a loading solution 0.004 M in uranium and 0.15 M in total sulfate, an "apparent" uranium diffusion coefficient in 1200μ Dowex 21K of $1.3 \times 10^{-7}$ sq cm/sec was measured. A single experiment was performed confirming the feasibility of steam stripping for removing $HNO_3$ from concentrated solutions of SS, Th, and U. In one run using boiling 4 M $H_2SO_4$ as the dissolvent 17.67 kg of stainless steel plate was completely dissolved in 2.75 hrs resulting in a reaction rate of 2.43 mg/sq cm-min and an average product loading of 75.2 g SS/liter as compared to a reaction rate of 1.85 mg/cm-min and product loading of approximately 60 g SS/liter when using 6 M $H_2SO_4$ at comparable operating conditions. Cake washing experiments made on siliceous solids centrifuged from Darex (APPR) solvent extraction feed solutions, in 5-in. and 12-in. centrifuges, demonstrated that the weight of uranium retained in the centrifuge after n batch washes can be predicted by the simple dilution-decantation formula $Y_n/Y_o = (1-F)^{n+1}$. Assembly of the SRE decladding machine was completed. In studies on the flow capacity and stage efficiency of pulsed columns as a function of operating variables and cartridge design with a typical flowsheet for Yankee Atomic fuel, the flow capacity of a compound extraction-scrub column with a sieve-plate cartridge (0.125-in. holes, 23% free area, 2-in. spacing) was limited by flooding in the scrub section. Two additional batch waste calcination tests were performed with Darex waste in an 8-in. diam by 48-in. long pot to assess the effects of higher feed rates on calciner operability and product characteristics. (For preceding period see CF-59-9-69.) (auth)

**10520** CF-59-11-54
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] NOVEMBER 1959. J. C. Bresee, J. O. Blomeke, P. A. Haas, R. W. Horton, A. D. Ryon, C. D. Watson, and M. E. Whatley. 66p. OTS.

A steady state, uranyl nitrate concentration profile was established across a water-TBP interface and was analyzed by means of photographic photometry. Survey of the literature indicated that $H_2$ and CO in the helium coolant of the gas-cooled reactor may be oxidized to $CO_2$ and $H_2O$ in a bed of mixed copper oxides at bed temperatures between 1000 and 1200°F with less than 1 ppm $O_2$ in the effluent gas. Classification of the 38 pounds of $2\mu$ flame calcined thoria was completed. Studies of uranium loading rate on sulfate-equilibrated $1200\mu$ Dowex 21K from average sulfate solutions continued to give apparent uranium diffusion coefficients of approximately $1.3 \times 10^{-7}$ sq cm/sec for sulfate concentration up to 0.30 $\underline{M}$. In the Thorex core dissolution of unirradiated Consolidated Edison fuel pellets ($UO_2-ThO_2$, 96%) using a flooded pot recycle technique (dissolver product is continuously combined with feed dissolvent), approximately 90% of the pellets was dissolved in 8 hrs. The results of 13 semi-continuous Sulfex dissolutions of 304L stainless steel with boiling 6 $\underline{M}$ $H_2SO_4$ and 4 $\underline{M}$ $H_2SO_4$ showed that the reaction rates and product solution loadings were 15 to 18% and 12% higher, respectively, for the 4 $\underline{M}$ acid for the same ratios of dissolvent flow rate to initial surface area. Centrifugation tests of Sulfex declad liquors produced centrifuge cakes averaging 0.5 volume % of the initial volume. In a single batch leaching of 3.9 kg of U as unirradiated $UO_2$ from 0.4-in. diameter stainless steel jacketed tubular fuel in boiling 13 $\underline{M}$ $HNO_3$, the uranium was dissolved in ~35 minutes at an average rate of 0.044 g/min-g of U initially present. Work was started to evaluate the flow capacity and stage efficiency of pulse columns as a function of operating variables and cartridge design for application to reprocessing power reactor fuels. A study of the sorption of $UF_6$ from a stream diluted by a gas inert to NaF has been undertaken to provide data for careful design of sorption systems. Initial tests with the 8-in. diam by 78-in. long pot calciner under conditions of maximum feed rate indicated the need for additional de-entrainment within the pot to prevent solids buildup in the off-gas line. (For preceding period see CF-59-10-77.) (auth)

**10521** CF-59-12-49
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT [FOR] DECEMBER 1959. J. C. Bresee, J. O. Blomeke, P. A. Haas, R. W. Horton, A. D. Ryon, C. D. Watson, and M. E. Whatley. Mar. 3, 1960. 44p. OTS.

The experimental study of the direct reduction of $UF_6$ with sodium was terminated. Flooding and holdup studies were conducted on the first model of the stacked clone contactor ($^3/_4$-in. top clone diameter) with kerosene (Supersol) and 0.08 $\underline{M}$ $HNO_3$. The preparation of high density $ThO_2$ powders and the effects of size distribution on packed densities were studied for application to vibratory compaction of $ThO_2-UO_2$. An experimental facility was designed to synthesize contaminated EGCR coolant helium and test purification system components. The apparent uranium diffusion coefficient was $1.1 \times 10^{-7}$ sq cm/sec when uranium was loaded on nitrate equilibrated $1200\mu$ Dowex 21K from a 0.004 $\underline{M}$ uranyl sulfate solution and $1.5 \times 10^{-7}$ sq cm/sec when uranyl sulfate equilibrated resin was eluted with 1 $\underline{M}$ $NaNO_3$. Declad times of ~24 min were required in flooded pot dissolutions with 5 $\underline{M}$ $HNO_3-2$ $\underline{M}$ HCl to totally declad two $5\frac{1}{2}$-in. long, 20-mil wall Consolidated Edison prototype pins containing ~25 g stainless steel, in the presence of $UO_2-ThO_2$ pellets. Nearly full scale Sulfex decladding runs showed that the dissolution rate for prototype fuel elements similar to the NMSR elements were 30% less than predicted from plate dissolution data. Sulfex liquors were successfully clarified at rates as high as 0.45 liter/min by a 12-in. centrifuge. The mechanical auxiliary decladder die was successfully tested with a SRE type element. None of the protective coatings tested in water at 125 to 157°F for use in the PRFPPP canal withstood $3 \times 10^9$ r, gamma exposure. Essentially complete attenuation of a $Cr(NO_3)_3 \cdot 9H_2O$ (Cr-51 tracer) aerosol was achieved in a packed distillation tower with 0.28 to 0.53 mol fraction non-condensable gas. (For preceding period see CF-59-11-54.) (auth)

**10522** CF-60-1-119
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION, CHEMICAL DEVELOPMENT SECTION C PROGRESS REPORT FOR DECEMBER 1959 AND JANUARY 1960. K. B. Brown, K. A. Allen, C. A. Blake, C. F. Coleman, D. J. Crouse, A. T. Gresky, and B. Weaver. Mar. 4, 1960. 48p. OTS.

The recovery of Th from Blind River ion exchange barrens with di(2-ethylhexyl)phosphoric acid was investigated. The recovery of Tc and Np from fluorination plant residues with tertiary amine was studied. The extraction of $Np^{4+}$ by quaternary ammonium nitrates is reported. A solvent recovery procedure involving successive use of $Na_2CO_3$–washing and $Al_2O_3$–adsorption was demonstrated in laboratory tests as a possible method for the purification and decontamination of organophosphorus process solvents. The effect of nitrated fractions of Amsco 125-82 on Zr–Nb extractions by TBP was investigated. Treatment of TBP-Amsco 125-82 solutions with 2 $\underline{M}$ $HNO_3$ at 60°C for 1 to 48 hr showed that under these mild conditions the TBP degradation products were more important than those from Amsco as contributors to Zr–Nb extraction and as affecting efficiency of solvent clean-up. The interfacial tensions between benzene solutions of several amine salt and alkyl phosphate extractants and aqueous solutions were examined as functions of the solute concentrations. (For preceding period see CF-59-11-132.) (W.L.H.)

**10523** CF-60-3-21
Oak Ridge National Lab., Tenn.
APPLICATIONS OF MAGNESIUM DIFFUSION TO THE REPROCESSING OF ZIRCONIUM-CLAD FUEL ELEMENTS. J. I. Federer. Mar. 4, 1960. 28p. OTS.

The applications of magnesium diffusion into zirconium- and Zircaloy-2-clad fuel elements were studied to determine whether the resulting alloys were amenable to reprocessing. Magnesium rapidly diffuses along the grain boundaries of zirconium and Zircaloy-2 at 625°C, causing grain-boundary embrittlement. Complete penetration of a nominal cladding thickness of 0.030 in. requires a diffusion time of about 2.5 hr. The effects of magnesium grain-boundary diffusion on zirconium and Zircaloy-2 were studied by corrosion and mechanical deformation tests. Acid solutions used in the corrosion tests were 16 $\underline{M}$ $HNO_3$, 5 $\underline{M}$ $HNO_3-2$ $\underline{M}$ HCl, 6 $\underline{M}$ HCl, 4 $\underline{M}$ $H_2SO_4$, and 13 $\underline{M}$ $HNO_3-0.04$ $\underline{M}$ HF. The 6 $\underline{M}$ HCl solution was found to promote intergranular corrosion. Mechanical deformation was successful in removing magnesium-penetrated zirconium cladding from uranium rods. Either intergranular corrosion or mechanical deformation may be used to reduce the material to small particles which are more suited for permanent waste disposal than are bulk corrosive solutions. (auth)

**10524** CF-60-3-50
Oak Ridge National Lab., Tenn.
ESTIMATE OF POTENTIAL FUEL REPROCESSING, REVISION NO. 30, PART A. J. W. Ullmann. Mar. 15, 1960. 9p. OTS.

The power and estimated reprocessing load are tabulated for existing and proposed United States and United States-built reactors of 10 kw or greater thermal power. (auth)

**10525** HW-11276
Hanford Works, Richland, Wash.
PROPERTIES OF THE SYSTEM URANYL NITRATE–ALUMINUM NITRATE–NITRIC ACID (OR SODIUM HYDROXIDE)–SODIUM NITRATE–WATER–HEXONE. PART 2. DENSITY, APPARENT MOLAR VOLUME AND VISCOSITY. L. L. Burger, I. M. Rehn, H. R. Schmidt, and C. M. Slansky. Mar. 22, 1949. Decl. Feb. 11, 1960. 38p. Contract W-31-109-eng-52. OTS.

The viscosity and density of various Redox Process solutions were determined at 15, 25, and 40°C. Apparent molar volumes for $UO_2(NO_3)_2$ and $HNO_3$ in hexone and in aqueous solutions were calculated from the density data as a function of concentration. The molar volumes of $Al(NO_3)_3$ in water and of hexone in water were also determined as well as the molar volume of water in hexone. A method was found for calculating the density of mixtures of $Al(NO_3)_3$, $UO_2(NO_3)_2$, and $HNO_3$ at high concentrations from curves of apparent molar volumes of the individual salts in water. Expressions were derived for viscosity of the solutions as a function of mole fractions of constituents. (L.T.W.)

**10526** HW-60436
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
PARAMETERS OF DISSOLVER EQUIPMENT DESIGN POWER FUEL REPROCESSING. W. A. Graf. May 20, 1959. 8p. Contract W-31-109-Eng-52. OTS.

The design parameters affecting dissolver design are enumerated and used to evaluate a design for the Interim Reprocessing Program. Maximum flexibility is emphasized with equipment capabilities ranging to chopped and whole elements, coating and core removal in separate steps, or core leaching. The circulating system with cylindrical cribs is preferred, and the design must have a geometry suitable for processing 5% enriched material. Fabricated Hastelloy is specified for the initial design with a later change to a more corrosion-resistant material. (T.R.H.)

**10527** HW-60455
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
THE EFFECT OF SOLUTION AND VESSEL THERMAL EXPANSION ON VOLUME MEASUREMENTS IN THE CHEMICAL PROCESSING DEPARTMENT. W. H. Johnson. May 22, 1959. 8p. Contract W-31-109-Eng-52. OTS.

The effects of solution and vessel temperature on volume measurements used for accountability purposes are discussed. General cases involving solution expansion and vessel metallic expansion are considered, and specific cases related to solutions such as Purex, Redox, and UNH are analyzed mathematically. (J.R.D.)

**10528** NP-8460
Canada. Dept. of Mines and Technical Surveys. Mines Branch.
RECOVERY OF URANIUM FROM AN ACID LEACH LIQUOR, USING AN ANION EXCHANGE RESIN AND SODIUM CARBONATE AND BICARBONATE AS ELUTING AGENTS. E. Kornelsen, V. M. McNamara, and J. C. Ingles. June 2, 1959. 52p. Available as Can. Dept. Mines and Tech. Surveys, Mines Branch, Research Rept. R-33.

It has been shown that it is possible, using both sodium carbonate solution and sodium bicarbonate solution as eluting agents, to remove uranium completely from Amberlite IRA-400 anion exchange resin loaded from an acid leach liquor. During 51 cycles of loading and elution, the resin sample used showed only slight deterioration. The uranium was precipitated from the eluate by means of sodium hydroxide. The precipitate assayed 82.7% $U_3O_8$, but was over specification in thorium content. (auth)

**10529** ORNL-2468
Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION MONTHLY PROGRESS REPORT FOR DECEMBER 1957. Apr. 11, 1958. Decl. Nov. 24, 1959. 43p. Contract W-7405-eng-26. OTS.

Feed Materials Processing. In the Metallex Process the separation of Th from ~180 gal of Th amalgam remaining from previous reduction runs was completed. Thirty-five grams of U as $UF_6$ was reduced at 356°C by 3.5 M Na amalgam in ~20% yield. In the DRUHM Process a helium blanket around the $UF_6$ inlet line was partially effective in reducing inlet line corrosion. In a 4-hr operation of the Fluorox Process fluidized bed oxidation reactor, 80 g of U was recovered as $UF_6$ from the cold trap; 190 g of U, as $UF_4$, was charged. Heterogeneous Power Reactor Fuel Processing. In studies on the Darex Process, a 13-hr loop run was made at an average V/L ratio of 0.88 and a stainless steel dissolution rate of 6.12 g/min. In Zircex Process studies the use of a NaCl bed in series and following a settling chamber resulted in recovery of >99% of the uranium chloride produced during hydrochlorination of U–Zr alloy. In fluoride-catalyzed $HNO_3$ the dissolution rate of 96% $ThO_2$–4% $UO_2$ pellets was maximum in 13 M $HNO_3$–0.04 M NaF. A simulated APDA fuel pin (Zr-clad U–Mo alloy) dissolved in 13 M $HNO_3$–0.5 M HF without the addition of heat, forming a stable solution. The stainless steel cladding of an APPR fuel element (sintered $UO_2$–stainless steel core) in 4 M $H_2SO_4$ followed by dissolution of the core in 8 M $HNO_3$ resulted in loss of 0.033% of the U to the residual solids. Hydrofluoric acid, added so that its concentration never exceeded 5 M, dissolved Zircaloy-2 jackets from PWR fuel elements with a U loss of 0.24%. The liquid metal fuel 98.7% Bi–1.3% U dissolved readily in 8 M $HNO_3$. In the Thorex Process two pilot plant runs, HD-27 on long-decayed Th and SD-3 on 4000-g/t, 30-day-decayed Th, were completed. The processing of ORNL tank farm wastes was completed. The Fused Salt–Fluoride Volatility Process pilot plant was modified to permit processing of the ARE fuel. (W.L.H.)

**10530** ORNL-2761
Oak Ridge National Lab., Tenn.
RECOVERY OF URANIUM AND THORIUM FROM GRAPHITE FUELS. I. LABORATORY DEVELOPMENT OF A GRIND-LEACH PROCESS. M. J. Bradley and L. M. Ferris. Apr. 1, 1960. 38p. Contract W-7405-eng-26. OTS.

A grind-leach method is presented for the recovery of U from uranium-graphite fuel elements. With unirradiated graphitized high-density reimpregnated fuel ground to −200 mesh containing 5.5 to 14 wt.% U and less than 0.4% Fe, 99.9% or more of the U was recovered with two leaches of boiling 15.8 M $HNO_3$ and thorough washing of the graphite residue. Yields were 0.1 to 0.2% lower when the fuel was ground to only −4 +8 mesh. Recovery of U decreased rapidly with decreasing U concentration in the fuel, rendering the grind-leach method unsuitable for fuels containing less than 3% U. The gases evolved during leaching were a mixture of nitrogen oxides. No volatile carbon-containing gas was found. Preliminary data indicated that about 3.2 moles of nitric acid was consumed per mole of metal when O was excluded from the system, suggesting that, in fuel specimens which had been exposed to the laboratory atmosphere for months, the U was present as $UO_2$ rather than $UC_2$. Leaching of −200 mesh samples of 1.5% U−7.2% Th-graphite fuel with boiling 15.8 M $HNO_3$ resulted in maximum U and Th recoveries of about 90%. Leaching with 15.8 M $HNO_3$−0.04 M NaF−0.04 M $Al(NO_3)_3$ offered no advantages. Combustion of the fuel followed by dissolution of the U and thorium oxide products in boiling 13 M $HNO_3$−0.04 M NaF−0.04 M $Al(NO_3)_3$ resulted in essentially quantitative recovery of the metals. A survey of processing methods indicated that combustion and digestion or particle size disintegration and leaching are the better possibilities for graphite fuels. (auth)

**10531** ORNL-2848
Oak Ridge National Lab., Tenn.
TRIBUTYL PHOSPHATE-HYDROCARBON DILUENT REPURIFICATION IN RADIOCHEMICAL PROCESSING AT ORNL: STATUS SUMMARY. Wallace Davis, Jr. Mar. 24, 1960. 27p. Contract W-7405-eng-26. OTS.

The need for, and the adequacy of, the sodium carbonate washing technique in chemical purification of tributyl phosphate-hydrocarbon extractant prior to its re-use in radiochemical processing was examined, primarily in terms of Ru, Zr, and Nb activities. Operating experience from ORNL Purex and Thorex Pilot Plants is compared with Hanford operations and upper limits for activities are suggested. Recommendations are made for development studies with the ORNL Power Reactor Fuel Processing Pilot Plant. (W.D.M.)

**10532** ORNL-2905
Oak Ridge National Lab., Tenn.
MODIFIED ZIRFLEX PROCESS FOR DISSOLUTION OF 1−10% U−Zr ALLOY FUELS IN AQUEOUS $NH_4F$−$NH_4NO_3$−$H_2O_2$: LABORATORY DEVELOPMENT. T. A. Gens. Mar. 18, 1960. 23p. Contract W-7405-eng-26. OTS.

A modified Zirflex process was developed in the laboratory for dissolution of 1 to 10% uranium−zirconium alloy fuels to produce a nitrate solution from which uranium can be recovered by conventional solvent extraction methods. A flowsheet is presented for dissolution of 7% uranium−zirconium alloy in 5.4 M $NH_4F$−0.33 $NH_4NO_3$. Enough 1 M $H_2O_2$ is added continually during dissolution to yield 0.13 M $H_2O_2$ in the final solution, neglecting the amount reacting. Dissolution is complete in 1 hr. The solvent extraction feed is prepared by adding aluminum nitrate and nitric acid to the dissolver solution to yield a stable solvent extraction feed solution of 0.0075 M uranium, 0.25 M zirconium, 1 M aluminum, 2 M fluoride, and 1 M $HNO_3$. The off-gas is approximately 98.5% $NH_3$, 1% $H_2$, 0.3% $O_2$, and 0.2% $N_2$. Conventional stainless steel such as 309SNb, Ni-o-nel, or Hastelloy F appears to be a suitable material of construction with corrosion rates varying from 0.1 to 3.0 mils/month. (auth)

**10533** RDB(W)-TN-21
Gt. Brit. Windscale Works, Sellafield, Cumb., England.
A METHOD FOR CLEANING AQUEOUS SOLUTIONS IN THE PLUTONIUM PURIFICATION AND RECOVERY PROCESSES FROM ORGANIC MATTER, BY TREATMENT WITH BENZENE IN A PACKED COLUMN. F. Roberts and W. D. Jones. Mar. 18, 1952. 11p.

**10534** AEC-tr-4015
THE ELECTROLYTIC SEPARATION OF CARRIER-FREE STRONTIUM FROM AQUEOUS SOLUTION. Günter Herrman. Translated by Gretchen Riese (Los Alamos Scientific Lab.) from J. Inorg. & Nuclear Chem. 7, 129-32(1958). 8p. JCL.

The electrolytic deposition of Sr from weak aqueous $HNO_3$ was investigated. Carrier-free Sr is deposited on the cathode with a yield of 80 to 90% when $CO_2$ is bubbled through a solution of pH value 2.5 to 6.2. (auth)

**10535**
THE SEPARATION OF LEAD-212 FROM THORIUM. T. T. Gorsuch (Radiochemical Centre, Amersham, Bucks, Eng.). Analyst 85, 225-6(1960) Mar.

The separation of $Pb^{212}$ from Th by adsorption of the lead on a column of anion-exchange resin and elution with distilled water is described. (C.J.G.)

**10536**
POROUS METAL FILTERS IN NUCLEAR FUEL PROCESSING. Chem. Eng. Progr. 56, No. 3, 96; 98(1960) Mar.

The porous metal filters used in fuel processing by the Zircex process are described. This filter, made of Inconel, has an average pore size rating of one micron. (C.J.G.)

**10537**
REMOVAL OF FISSION PRODUCT ELEMENTS BY SLAGGING. L. J. Mullins, J. A. Leary, and W. J. Maraman (Los Alamos Scientific Lab., N. Mex.). Ind. Eng. Chem. 52, 227-30(1960) Mar.

The separation of plutonium from fission products in spent reactor fuels by oxide and chloride slagging was investigated. Experiments with magnesia showed temperatures of approximately 1400°C were required to achieve reasonable rates of removal of Ce and La. Rare earth separation was significantly faster at 1400 than 1200°C. The effect of slagging time at 1400°C on the recovery of plutonium using magnesia and zirconia crucibles was studied. The removal of fission product elements by $PuCl_3$−NaCl and $MgCl_2$−KCl−LiCl slags at 600°C was investigated. (C.J.G.)

**10538**
INFLUENCE OF SOME IONS ON THE PRECIPITATION OF URANYL FERROCYANIDE FROM AQUEOUS SOLUTIONS. V. G. Sochevanov, N. V. Shmakova, and G. A. Volkova. Zhur. Anal. Khim. 15, 77-83(1960) Jan.-Feb. (In Russian)

The influence of some cations and anions on the precipitate composition formed by the reaction of uranyl and errocyanide ions was studied by the amperometric titration method. It was shown that $NH_4^+$, $Na^+$, $Mg^{2+}$, $Al^{3+}$, $Cr^{3+}$, $Ce^{3+}$, $VO_3^-$, $CrO_4^-$, and $Cl^-$ do not change the composition of uranyl ferrocyanide and do not interfere with the titration. $Zn^{2+}$, $Cu^{2+}$, $Ni^{2+}$, $Pb^{2+}$, $Fe^{3+}$, $Th^{4+}$, $MoO_4^{2-}$, $PO_4^{3-}$, and $SO_4^{2-}$ ions interfere forming, in some cases, more complicated compounds. (auth)

**10539**
SEPARATION OF URANIUM FROM ACCOMPANYING METALS BY ION EXCHANGE CHROMATOGRAPHY. D. I. Ryabchikov, P. N. Palei, and Z. K. Mikhailova (Vernadskii Inst. of Geochemistry and Analytical Chem-

istry, Moscow). Zhur. Anal. Khim. 15, 88-95(1960) Jan.-Feb. (In Russian)

The separation of uranium from accompanying elements by ion exchange chromatography using complexone III is described. The separation was found possible in two cases. In acid mediums, where the uranium is present as a positive ion, the majority of accompanying elements form an anion complex with complexone III and are not adsorbed with cationite. In almost neutral mediums uranium is present as an unstable anion complex and can be adsorbed with carboxylic resin after the decomposition of this complex. The separation of uranium from solutions at pH 1.7 to 1.9 on cationite in sodium form was found to be applicable to materials rich in uranium. The separation of uranium from solutions at pH 5 to 8 on amberlite cationite in sodium form was found applicable to rich and poor uranium ores and uranium solutions as well. (auth)

**10540**
METHOD FOR REFINING AND SEPARATING A METAL SELECTED FROM THE GROUP CONSISTING OF TITANIUM, ZIRCONIUM, CERIUM, HAFNIUM AND THORIUM. Stanislaw Teodor Jazwinski and Joseph Anthony Sisto (to Barium Steel Corp.). British Patent 828,239. Feb. 17, 1960.

A method for refining and separating Ti, Zr, Ce, Hf, and Th is given which involves distillation of carbonyl complexes. Powdered Ti, for example, is agitated and heated in a vessel to 400°C at a pressure of 4 to 8 atm. of a rare gas and enough CO to react to form liquid $Ti(CO)_7$. This liquid is vaporized and led to a precipitation chamber where re-heating decomposes the carbonyl complex leaving pure metal. (T.R.H.)

**10541**
PROCESS OF REMOVING RARE EARTHS FROM AQUEOUS URANIUM SOLUTIONS. (to United Kingdom Atomic Energy Authority). British Patent 829,639. Mar. 2, 1960.

A process for treating homogeneous reactor fuel solutions is described which removes rare earths. In an example, a uranyl sulfate solution containing rare earths was put in an autoclave with powdered $CaF_2$ and heated and rocked at 250°C for one hour. It was found that the $CaF_2$ had removed all the rare earths and none of the uranium. (T.R.H.)

# ENGINEERING AND EQUIPMENT

## General and Miscellaneous

**10542** AECU-4711
Goodyear Tire and Rubber Co., Akron, Ohio.
ISOTOPIC METHOD FOR AGE DETERMINATIONS OF INDUSTRIAL PRODUCTS. Monthly Progress Letter [for] January 1960. T. C. Gregson and L. B. Bangs. 5p. Contract AT(11-1)-719. OTS.

Preliminary progress is reported in an investigation of the application of isotopes in age determination of industrial products. Instrumentation design and acquisition and isotope selection for tire and gasoline studies are described. (T.R.H.)

**10543** AECU-4724
Goodyear Tire and Rubber Co., Akron, Ohio.
ISOTOPIC METHOD FOR AGE DETERMINATION OF INDUSTRIAL PRODUCTS. Quarterly Progress Report for October—December 1959. T. C. Gregson and L. B. Bangs. 52p. Contract AT(11-1)-719. OTS.

Research devoted to development of isotopic methods for dating manufactured items is described. Cured rubber tread formulations containing isotopes such as $C^{14}$, $S^{35}$, $Cl^{36}$, $Ca^{45}$, $Sr^{89}$, and $Tc^{99}$ were used. Tagged products were also used to study perturbations from self-absorption in the material. Samples containing $Cl^{36}$, $Sr^{89}$, and $Tc^{99}$ were used. Results are tabulated and discussed. Similarly tagged product material samples were used to investigate the feasibility of measuring isotope ratio directly by means of internal liquid scintillation suspension counting. Most isotope pairs used in demonstrating the principle of this technique were pure beta emitters; however, equations were developed for an emitting pair in which the timer species generates safer radiation than does the reference standard. Utility pairs composed of mixed beta and gamma emitters was also investigated. Data on measured ages of product-free isotope mixtures compared with their actual ages are included. Analyses of data obtained during the quarter include estimation of the effects on computed ages of factors such as statistical errors, half life of timer in relation to age period, relative initial concentration of standard and timer, isotopic impurities, and decay of the reference standard. A table of isotope pairs recommended for age periods of 2 weeks to 120 years is included. (For preceding period see AECU-4441.) (J.R.D.)

**10544** AERE-R-3201
United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England.
A METHOD FOR SEALING LITHIUM FLUORIDE WINDOWS TO PYREX VACUUM SYSTEMS. P. C. Wildy. Jan. 1960. 5p. BIS.

A technique is described for sealing lithium fluoride windows to pyrex tubing using seals of silver chloride with intermediate silver rings. Vacuum systems using these seals were satisfactory for several years. (J.R.D.)

**10545** APDA-134
Atomic Power Development Associates, Inc., Detroit.
SODIUM COMPONENTS TEST FACILITY. Nov. 1959. 208p. Contract AT(11-1)-772. OTS.

The design and construction of a test facility that will be capable of subjecting sodium components to both steady state and transient conditions expected in full size nuclear power electric generating stations are presented. This study encompasses design criteria, an estimate of time required to construct, and a survey of existing facilities to be selected by mutual agreement of the commission and APDA which would be suitable to accommodate the desired tests. (W.L.H.)

**10546** BMI-1416
Battelle Memorial Inst., Columbus, Ohio.
EXAMINATION OF A NONREGENERATIVE HEAT EXCHANGER FROM THE U.S.S. NAUTILUS (SSN-571). Warren E. Berry, Oliver M. Stewart, and Frederick W. Fink. Feb. 19, 1960. 55p. For Westinghouse Electric Corp. Bettis Atomic Power Lab. Contract NObs-67500, Subcontract 73-(00-929). OTS.

Selected components from a stainless steel nonregenerative heat exchanger removed from the U.S.S. Nautilus (SSN-571) have been examined for evidence of stress-corrosion cracking. The examination was conducted on three baffle plates, all primary-face seal welds, and the tubes and the surrounding tube sheets of 7 out of a total of 35 tubes. Maximum operating temperature of the heat exchanger was 260°F for the inlet primary water and 164°F for the exit secondary water. Chloride content of the secondary water averaged 5 ppm, with a maximum of 15 ppm. Only one suspected stress-corrosion crack was found in the components normally in contact with the secondary water. The crack, 2.5 mils in depth, was located on a fully exposed tube. At the 95 per cent confidence level this represented a probability of finding cracking on fully exposed surfaces in 0 to 60 per cent of the rest of the tubes in the heat exchanger. Severe stress-corrosion cracking was found in tubes in the tube-sheet drain area at the juncture with the inner tube sheet at the inlet end, where secondary water seeped past the expanded tubes. Cracks were detected in five of seven tubes for a statistical probability of 25 to 96 per cent at the 95 per cent confidence level. Maximum depth of cracks was 28 mils or 80 per cent penetration of the 35-mil-thick tubing wall. Stress-corrosion cracks also were found around several holes on the drain-side tube-sheet surfaces at the inlet end. Maximum depth was 12 mils, which did not seriously threaten penetration of the $^9/_{16}$-in.-thick tube sheet. Cracks were detected in 5 of 35 primary-face seal welds at the inlet end and in 11 of 35 at the outlet end. This behavior was attributed to hot-short cracking of the Type 347 stainless steel weldments rather than to stress corrosion. (auth)

**10547** KAPL-M-SMS-104
Knolls Atomic Power Lab., Schenectady, N. Y.
COMPARATIVE PERFORMANCE OF FOUR MAIN COOLANT CHECK VALVES DURING CLOSURE. T. H. Glasser, D. R. Miller, R. C. Samler, R. F. Wojecieszak, and R. G. Kennison. Dec. 16, 1959. 35p. OTS.

An investigation is reported which sought to minimize surge pressures during closing of main coolant check valves. Four fast-closing designs were analyzed and a preliminary study was made of dashpots. (T.R.H.)

**10548** ORNL-2688
Oak Ridge National Lab., Tenn.
A SAMPLING DEVICE FOR MOLTEN-SALT SYSTEMS. W. B. McDonald and J. L. Crowley. Mar. 21, 1960. 5p. Contract W-7405-eng-26. OTS.

The design and use of a sampling system which permits the removal of operating-fluid samples from a forced-circulation corrosion-testing loop while the loop is in operation are described. The device is mounted over the one free surface of the fluid and utilizes a dip tube which can be inserted into the liquid and removed without contaminating the inert cover gas of the system. (auth)

**10549** ORNL-2876
Oak Ridge National Lab., Tenn.
SOLIDS SEPARATION BY A HYDRAULIC CYCLONE WITH A BATCH UNDERFLOW RECEIVER. P. A. Haas. Mar. 18, 1960. 48p. Contract W-7405-eng-26. OTS.

Engineering correlations based on experimental studies are presented for the application of batch accumulation of solids separated from solid-liquid feed to a cyclone. This method of cyclone operation simplifies the problem of flow control involved with continuous underflow. The efficiency and capacity correlations for hydroclones with continuous underflow also apply to this type of operation. The volume flow exchanged with the underflow receiver may be varied from 0.2 to 6% of the feed flow volume by varying the hydroclone dimensions. Minimum ratios of the feed to underflow receiver concentrations can be predicted, and values of up to $10^4$ were obtained experimentally. This technique was used for both the concentration of solids and the clarification of the liquid phase with hydroclones in the size range of 0.16 to 3.5 in. diam. (auth)

**10550** RISLEY-5230
United Kingdom Atomic Energy Authority. Industrial Group. Windscale Works, Sellafield, Cumb., England.
THE DESIGN, CONSTRUCTION AND OPERATION OF A REMOTELY-CONTROLLED SHIELDED LATHE UNIT FOR THE MACHINING OF HIGHLY ACTIVE MATERIALS. A. J. Howarth. Jan. 7, 1955. 21p. (ARDC/P-49; WTSC/R-187).

A Myford ML7 lathe installed in a fume-hood with a shield of eight inches of iron to protect the operator, was modified for the accurate machining of a highly active (approximately 50 curies 0.7 Mev gamma) irradiated uranium rod by fully remote control. Modifications made to the lathe, the remote control mechanisms, and the special coffin for the conveyance and insertion of the highly active rod are described. Details of machining procedure, collection of cut metal samples and the measures taken to cover safety aspects are also outlined. Drawings and photographs are included. Recommendations are made on future applications of the unit to similar problems. (auth)

**10551** SCR-129
Sandia Corp., Albuquerque, N. Mex.
CALIBRATION OF MACH 2 NOZZLE BLOCKS WITH 6% PERFORATED-WALL TEST SECTION. W. T. Botner, H. R. Spahr, and R. C. Maydew. Nov. 1959. 14p. OTS.

Presented at Tenth Supersonic Tunnel Association Meeting, Cornell Aeronautical Laboratory, Inc., Buffalo, New York, Oct. 1958.

The speed range of the Sandia 12-by-12-inch transonic wind tunnel was recently increased from Mach 1.35 to Mach 2.0 by the installation of interchangeable fixed Mach 2 nozzle blocks. The installed blocks are shown. (auth)

**10552** SCR-130
Sandia Corp., Albuquerque, N. Mex.
FREE-OSCILLATION VARIABLE-DEFLECTION DYNAMIC RIG. R. C. Maydew and J. C. Weydert. Nov. 1959. 9p. OTS.

Presented at Tenth Supersonic Tunnel Association Meeting, Cornell Aeronautical Laboratory, Inc., Buffalo, New York, Oct. 1958.

Sandia Corporation Dynamic Rig No. 11 was designed to facilitate the dynamic stability testing of store models in the Sandia Corporation 12″ × 12″ blow down wind-tunnel facility. The rig was designed to provide a convenient and rapid method for shifting model center of rotation with respect to the rig oscillating head, and to make it possible to easily adjust the deflection mechanism to deflect and release the model at any angle desired within limits of the model and mechanism. Also, the rig has a locking unit which allows a model to be suddenly released from a zero angle orientation, and permits an oscillating model to be brought to rest. (auth)

**10553** SCTM-9-60(25)
Sandia Corp., Albuquerque, N. Mex.
MOLDED RUBBERIZED HAIR SHOCK MITIGATING AND CUSHIONING PADS. W. W. Chapin. Jan. 20, 1960. 10p. OTS.

Proven standard specifications are described. Various factors affecting fabrication, inspection, and quality control are discussed. (auth)

**10554** SCTM-361-59(14)
Sandia Corp., Albuquerque, N. Mex.
TRANSMISSION OF SHORT DURATION ACCELERATION PULSES. M. L. Walker and P. M. Barba. Dec. 21, 1959. 22p. OTS.

A unit which is separated from its case by an ideal plastic material is dynamically analyzed when the case is subjected to an acceleration pulse. When the case of a unit experiences an acceleration pulse, the equations derived provide the following information: the magnitude of the plastic stress of the cushioning material and the thickness necessary to obtain a desired attenuation of the input acceleration pulse; the magnitude of the greatest attenuation of the input acceleration pulse when the space between the unit and the case is fixed, regardless of the type of cushioning material; and the minimum space for a cushioning material that must be available to obtain a desired attenuation, regardless of the type of cushioning material. (auth)

**10555** TID-4100(1st Rev. Suppl. 3)
Technical Information Service Extension, AEC.
ENGINEERING MATERIALS LIST. A Catalog of Drawings, Photographs, and Specifications Released by the United States Atomic Energy Commission. Richard E. C. Duthie, ed. June 1959. 149p.

The Engineering Materials List (EML), is a catalog of available U. S. Atomic Energy Commission unclassified engineering drawing materials on the peaceful applications of atomic energy. The engineering literature described in the EML includes drawings, specifications, photographs, bill of materials, cost analyses, design criteria, parts lists, and related document references. As additional materials are received by the Technical Information Service Extension (TISE), they will be announced in supplements or revisions to the EML. This supplement identifies additional engineering materials that have been assembled into 69 new packages totaling approximately 2,250 drawings. In addition, this supplement contains a revision of the materials available on the Tower Shielding Facility Instrumentation, CAPE-24, and on the Bubble Chamber (BNL), CAPE-145. The new cumulative Contents and Indexes cover all materials that have been announced in the EML to date. The Indexes will enable the user to locate materials by names of the organizations which originated the material, by subjects, and by original identification numbers. The EML and its supplements are distributed by TISE automatically to AEC contractors, to all AEC depository libraries, and to access permit holders in the AEC's Civilian Application Program. The general public may request this and future issues of the list from the U. S. AEC Technical Information Service Extension, P. O. Box 62, Oak Ridge, Tennessee. (auth)

**10556** TID-5621
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
RESISTANCE TEMPERATURE DETECTOR LEAD CABLE—100-K AREA. R. L. Loundagin. Dec. 9, 1957. 6p. (HWS-6244(Rev. 1)). OTS.

A specification is given for the procurement of resistance thermometer lead cable more suitable than that previously used. (W.L.H.)

**10557** TID-7571(p.14-20)
National Cooperative Refinery Assn., McPherson, Kan.
AN INDUSTRIAL APPLICATION OF COBALT 60. L. P. Aeschliman. 7p.

In October 1958, National Cooperative Refinery Association installed a radioactive detecting device to help determine the coke level inside the 16′ × 65′ coke chambers in their delayed coking unit. The reason for this installation was to help prevent over-filling of the chambers, resulting in carry-over of foam and tarry material into the vapor lines which resulted in plugging of lines and consequently pressure rises, forcing a premature shutdown of the unit. The economics of a refinery operation are such that if these premature shutdowns occur, there is not only the expense of cleaning out and getting back onstream, but also, because of a direct tie-in with the crude unit, a loss in crude throughput and products made, resulting in substantial reductions in potential earnings. By using this radioactive device, one can much more positively determine the rate of filling of a coke chamber and can feel more sure of our operation, resulting in not only eliminating unscheduled shutdowns but in many cases to run more crude oil through the unit and more nearly approach maximum coke production each day. (auth)

**10558** TID-7571(p.39-63)
Martin Co. Nuclear Div., Baltimore.
INDUSTRIAL UTILIZATION OF RADIOISOTOPES. Jerome G. Morse. 25p.

The fundamental basis upon which utilization of radioisotopes is predicated is that these materials emit radiation. In industrial operations radiation provides the necessary vehicle for the pursuit of the major application areas, which are tracing, gaging, radiography, and processing. Industrial incentives for use of these active materials in these applications focus upon the opportunity for dollar savings in many manufacturing operations, affording greater sensitivity in product control and performing tasks heretofore difficult or impossible. The availability of radioisotopes is increasing with time, and for most industrial applications sufficient quantity is available at modest cost. The applications presented represent a cross section of uses and do not cover all major areas. (auth)

**10559** TID-7571(p.92-114)
Phillips Petroleum Co. Research Div., Bartlesville, Okla.
USES OF RADIOISOTOPES IN THE PETROLEUM INDUSTRY. Charles E. Stoops. 23p.

The uses of radioactive isotopes in the petroleum industry are reviewed. Illustrations are given of these uses in well logging, production, refining, wear studies, and radiation chemistry research. (auth)

**10560** TID-7571(p.115-27)
Nuclear-Chicago Corp., Chicago.
TRACER APPLICATIONS. John L. Kuranz. 13p.

When low cost radioisotopes of wide variety were made available by the development of the chain reacting nuclear reactor, the potential importance of these new materials to industrial analysis and process control was recognized and expressed by many knowledgeable persons. The type and scope of many isotope applications are reviewed. Emphasis is placed on applications in gaging, in which material is identified and/or measured by observing its effect on a radioactive beam, neutron activation analysis in which material is identified and measured by the effect of a neutron beam on the material, and tracer analysis, in which identification or measurement of the material is made possible by addition of a radioactive reagent. (C.H.)

**10561** TID-7571(p.172-6)
Midwest Research Inst., Kansas City, Mo.
APPLICATIONS OF RADIOISOTOPES AT MIDWEST RESEARCH INSTITUTE. C. W. Stanley. 5p.

Radioisotopes have been applied to research as tracers and as radioisotope gages. Projects on which radioisotopes are being used as tracers are studies of paints, of a lubricant, of floor wax application, and of the degradation of sugars. Projects using radioisotope gages are a determination of the water content of glue and the development of a gage for the measurement of solids content of tomato juice. (auth)

**10562** WAPD-S3W-A-1865
[Westinghouse Electric Corp. Bettis Plant, Pittsburgh].
SIMULATION OF A STEAM GENERATOR. W. L. Cannon and L. L. Roth. Aug. 13, 1958. 61p. OTS.

A general mathematical model is developed for a sectionalized steam generator which consists of a downcomer, boiling section, riser, and steam drum. Equations describing thermal and hydraulic processes are written for each section and combined to form the integrated model. An analog simulation circuit is then described which successfully solves the equations. Simulated water level and steam pressure changes for different rates of steam flow ramps are compared with test data from the prototype steam generator to show the validity of the mathematical model and simulator circuit. The simulated water level changes are used as the main criteria for comparison and are within 7% of the test data for the increasing steam ramps. The simulated water level changes accompanying decreasing steam flow ramps, while not as closely corroborated because of scatter in the test data, are within the expected ±20% range of accuracy. (auth)

**10563** NP-tr-356
SCIENTIFIC PRINCIPLES FOR ENGINEERING AUTOMATIC CONTROL EQUIPMENT. (Nauchnyye Osnovy Postroyeniya Teknicheskikh Sredstv Avtomatiki). Translated from a publication of the Publishing House of the Academy of Sciences, U.S.S.R., Moscow, 1957. 200p. OTS.

The general problems of developing the technical means of automatic control are discussed. The development of new types of electronic, semiconductor, magnetic, and dielectric noncontact devices is reviewed. The present state and prospects for the application of radioactivity for controlling industrial processes were discussed. The uses of acoustic and ultrasonic devices were also investigated. Problems in the industrial application of radio-frequency and mass spectroscopy were analyzed. (W.L.H.)

**10564**
MAGNETICALLY DRIVEN FAST-ACTING VALVE FOR GAS INJECTION INTO HIGH VACUA. B. Gorowitz, K. Moses, and P. Gloersen (General Electric Aerosciences Lab., Philadelphia). Rev. Sci. Instr. 31, 146-8(1960) Feb.

A description is given of a valve suitable for use in studies involving the acceleration of plasmas into regions of high vacua. Valve opening durations of less than 60 μsec may be attained, and amounts of gas lower than 0.01 cc STP may be introduced. Valve performance characteristics and measuring techniques are discussed. (auth)

**10565**
RADIOACTIVE CYLINDERS. A TOOL FOR WEAR RESEARCH. Preprint 126A. W. C. Arnold and V. T. Stonehocker (Fairbanks, Morse and Co., Beloit, Wis.), W. J. Braun and D. N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). New York, Society of Automotive Engineers, Inc., 1960. 13p.

Cylinder wear in an engine was evaluated by irradiation of a cylinder liner and installation in the engine to be tested. Irradiation, handling, and installation techniques are discussed. The radioassay techniques for determining cylinder wear and for removing and concentrating radioactive debris from lubricating oil and exhaust gas samples are described. (C.J.G.)

**10566**
IMPROVEMENTS IN OR RELATING TO AUTOMATICALLY CLOSING VALVES. Henry Roberts (to Flight Refuelling, Ltd. and AEI-John Thompson Nuclear Energy Co., Ltd.). British Patent 826,870. Jan. 27, 1960.

A valve is described which is suggested for use on fuel rod charge-discharge openings. The arrangement includes a bellows and lever mechanism to effect removal of a fuel rod from a reactor without exposure. (T.R.H.)

**10567**
THREE-COMPONENT HEAT EXCHANGER FOR THERMAL POWER PLANTS, ESPECIALLY ATOMIC POWER INSTALLATIONS. (to Siemens-Schuckertwerke A.G.). German Patent DAS 1,060,882, Swiss Patent 173,859, French Patent 641,914, Belgian Patent 512,846, and U. S. Patent 1,382,670. Kerntechnik 2, 77(1960) Feb. (In German)

The invention of a three-component heat exchanger operating on the cross current method is reported. On the basis of operational safety, there should be a separation of the primary and secondary medium by means of an intermediate medium. The exchanger consists of two coiled tube systems separated from each other by an intermediate medium and of a central carrier pipe as inlet for the first medium and of numerous spirally coiled tubes lying on top of each other for the other medium. Mercury is used as the intermediate medium to separate the primary and secondary media. The exchanger can be used in reactor installations to reduce the possibility of a leakage of the primary system causing an explosion. (J.S.R.)

## Heat Transfer and Fluid Flow

**10568** AD-227572
Stanford Univ., Calif.
THE INFLUENCE OF TEMPERATURE DEPENDENT PROPERTIES ON GAS FLOW HEAT TRANSFER IN CIRCULAR TUBES. Technical Report No. 43. W. B. Nicoll and W. M. Kays. Sept. 1, 1959. 69p. Contract Nonr-225(23).

The present investigation attempts to experimentally determine the effect of large temperature differences for flow of air in a circular tube under the conditions of laminar flow heating, laminar flow cooling, and turbulent flow cooling. Experimental data are presented for laminar flow heating and cooling up to absolute temperature ratios of about 1.8, and for turbulent flow cooling for absolute temperature ratios from 1.5 to 2.7. The laminar flow heating data, despite temperature rises of as much as 1100°F, and temperature differences as high as 550°F, show negligible temperature dependent properties effects, and in fact correspond very closely to the Graetz solution (extended) if all properties are evaluated at local mixed-mean temperature. The laminar cooling data also correspond well with the Graetz solution for mean Nusselt number with respect to length, provided that properties are evaluated at the logarithmic mean temperature with respect to end temperatures and wall temperature. The turbulent cooling data show no detectible effect of temperature ratio when properties are evaluated at the logarithmic mean temperature. (auth)

**10569** ARGMA-TN-1H1N-9
Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala.
ONE-DIMENSIONAL COMPRESSIBLE FLOW TABLES FOR A PERFECT GAS IN MACH NUMBER INCREMENTS OF 0.001 (k = 1.24)—ISENTROPIC PROCESS. (Cover carries title: COMPRESSIBLE FLOW TABLES k = 1.24—ISENTROPIC PROCESS). C. Hoebich. Mar. 1960. 89p. Project TW 205C.

Functions of Mach numbers are tabulated for compressible perfect gas. The ratio of specific heats k is 1.24. The increment used in these tables is sufficiently small (0.001 Mach number) to eliminate time-consuming interpolation. These tables are for stagnation temperature change without friction. (auth)

**10570** CAL-77-P
Cornell Aeronautical Lab., Inc., Buffalo.
A SHOCK TUBE TECHNIQUE TO DETERMINE STEADY-FLOW LOSSES OF ORIFICES AND OTHER DUCT ELEMENTS. George Rudinger. Nov. 1958. 28p. Project SQUID. Contract Nonr-1858(25).

It is shown that a simple shock tube is capable of producing appreciable steady-flow rates through a short duct element, such as an orifice, a valve, or a screen. The flow upstream and downstream of the test element and, therefore, also the losses caused by the test element, can be calculated from known initial conditions in the shock tube and pressure measurements at one point upstream of the element. Experiments to determine the discharge coefficient of a sharp-edged orifice are described as an illustration of the method. The results are in good agreement with available steady-flow data. (auth)

**10571** CISE-71
Centro Informazioni Studi Esperienze, Milan.
TWO-PHASE COOLING EXPERIMENTS: PRESSURE DROP, HEAT TRANSFER AND BURNOUT MEASUREMENTS. A. Cicchitti, C. Lombardi, M. Silvestri, G. Soldaini, and R. Zavattarelli. 1959. 58p.

Results of pressure drop, heat transfer, and burnout tests with wet steam at high pressure are reported. These tests were conducted with the experimental facility built in the thermal power station at Piacenza, Italy. Data on stability in various flow patterns are included. (J.R.D.)

**10572** NAA-SR-Memo-4553
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
EXPERIMENTAL SYSTEMS AND PROCEDURES UTILIZED IN STUDYING THE PHENOMENA OF NUCLEATE BOILING AND BURNOUT. D. A. Huber. Oct. 22, 1959. 11p. OTS.

A survey of boiling heat transfer which was conducted at ten laboratories is given. The characteristics of experimental systems, burnout detection procedures, range of experimental conditions, and results obtained are listed for each laboratory. (J.R.D.)

**10573** NAA-SR-Memo-4666
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
HEAT TRANSFER AND THERMODYNAMIC PROPERTIES OF MERCURY. Paul D. Cohn. Nov. 18, 1959. 29p. OTS.

A literature search was made to evaluate the heat transfer and thermodynamic information available for mercury. At present, no completely theoretical evaluation of the forced convection, boiling, or condensing properties of this metal have been successful. Evaluations of information on forced heat transfer, boiling and condensing heat transfer coefficients, and thermodynamic properties of mercury vapor are presented. (J.R.D.)

**10574** NP-8415
Massachusetts Inst. of Tech., Cambridge. Div. of Sponsored Research.
TRANSITION BOILING HEAT TRANSFER FROM A HORIZONTAL SURFACE. Technical Report No. 17. Paul J. Berenson. Mar. 1, 1960. 117p. Project No. 7-8077.

An experiment, utilizing a condensing fluid as the heat source, was performed to determine the heat flux vs. temperature difference curve for transition pool boiling from a horizontal surface. The boiling curve was determined as a function of surface roughness, material, and cleanliness for n-pentane at atmospheric pressure. The results of the experiment show that the liquid contacts the solid heating surface in transition boiling. The burnout heat flux and the film boiling curve are independent of surface properties. For commercial heating surfaces, and probably provided that the combination of surface energies which exist do not result in spreading of the liquid on the solid heating surface, the location of the minimum point is independent of surface properties. It is concluded that transition boiling is a combination of unstable nucleate and unstable film boiling alternating at a given location on the heating surface. The heat transfer data in the transition region was found to be correlated by a straight line on log-log graph paper which connects the burnout point and the minimum point. The bubble spacing and growth rates in film pool boiling from a horizontal surface are shown to be determined by Taylor Hydrodynamic Instability for temperature differences near the minimum. An analytical expression for the heat transfer coefficient in film pool boiling from a horizontal surface is derived. Combining this equation with the equation for the minimum heat flux yields an analytical expression for the temperature difference at the minimum, which defines the location of the minimum point. The above equations agree with the experimental measurements made on n-pentane and carbon tetrachloride within ±10%. (auth)

**10575** NP-8424
California Inst. of Tech., Pasadena. Guggenheim Aeronautical Lab.
A KINETIC THEORY DESCRIPTION OF RAREFIED GAS FLOWS. Memorandum Report No. 51. Lester Lees. Dec. 15, 1959. 87p. DA Project No. 5B0306004. Contract DA-04-495-Ord-19.

An approach to the kinetic theory of gas flows is developed which starts with Maxwell's original integral equations of transfer, rather than with the Maxwell-Boltzmann equation for the velocity distribution function itself. In this procedure the Maxwell-Boltzmann equation is satisfied in a certain average sense, rather than at every point. The advantage of this method is that relatively simple distribution functions are utilized which contain a small number of unknown functions to be determined by applying the conservation laws, plus several additional higher moments. For simplicity a "two-stream Maxwellian" is employed, which is a natural extension and generalization of Mott-Smith's function for a normal shock, but differs from it in certain essential respects. As an illustration, the method is applied to linearized plane Couette flow and Rayleigh's problem. Reasonable results are obtained for macroscopic quantities such as mean velocity and shear stress over the whole range of densities from free-molecule flow to the Navier-Stokes regime. This technique is now being applied to some typical non-linear rarefied gas flows. (auth)

**10576** NP-8443
Purdue Univ., Lafayette, Ind. Rocket Lab. and Purdue Research Foundation, Lafayette, Ind.
THE ANALYTICAL DETERMINATION OF THE LOCAL HEAT TRANSFER CHARACTERISTICS OF GASES FLOWING TURBULENTLY IN THE THERMAL ENTRANCE REGION OF A CIRCULAR DUCT WITH LARGE TEMPERATURE DIFFERENCES BETWEEN THE GAS AND THE DUCT WALL. Helmut Wolf and M. J. Zucrow. Dec. 1957. 210p. Project SQUID. Contract N6-ori-105, T.O.III. (RM-57-2).

The mathematical description of flow with heat transfer is presented for a fluid flowing through a circular duct of constant area, under laminar and turbulent flow conditions. A review of the published literature is included that summarizes the analytical work pertinent to the calculation of heat transfer in the entrance region. A calculation of the heat transfer characteristics for air and carbon dioxide in the entrance region was made employing the boundary layer equations that were non-dimensionalized. The calculations were performed for the boundary conditions of constant heat flux (heating the gas), and constant wall temperature (cooling the gas); it was assumed that the velocity profile was fully developed and the temperature profile was uniform at the cross section where energy exchange was initiated. Local values of the Nusselt number and friction coefficient were calculated at nominal values of Reynolds number. The results indicate that the intensity of heating or cooling causes a much larger change in the local Nusselt number for air than for carbon dioxide, under similar conditions of flow at a given axial position. The calculated values of the friction coefficient in the presence of heat transfer did not vary appreciably with axial distance. Values of the thermal entrance length were computed as a function of the Reynolds number. Computed results are presented graphically and tabularly. (auth)

**10577** ORNL-2433
Oak Ridge National Lab., Tenn.
FUSED SALT HEAT TRANSFER—PART III: FORCED-CONVECTION HEAT TRANSFER IN CIRCULAR TUBES CONTAINING THE SALT MIXTURE $NaNO_2-NaNO_3-KNO_3$. H. W. Hoffman and S. I. Cohen. Mar. 17, 1960. 26p. Contract W-7405-eng-26. OTS.

Experimental heat-transfer coefficients were determined for the molten salt mixture $NaNO_2-NaNO_3-KNO_3$ (40-7-53 wt.%) flowing by forced convection through circular tubes. The variables ranged as follows:

| | |
|---|---|
| Reynolds modulus | 4,850 to 24,710 |
| Prandtl modulus | 4.2 to 9.1 |
| Average fluid temperature, °F | 552 to 828 |
| Heat flux, $Btu \cdot hr^{-1} \cdot ft^{-2}$ | 62,800 to 194,500 |

Within this set of conditions, the heat-transfer coefficient varied from 800 to 2900 $Btu \cdot hr^{-1} \cdot ft^{-2} \cdot (°F)^{-1}$ ($N_{Nu}$ from 35 to 125). It was concluded that heat transfer with this salt could be represented by the general correlations for forced-convection heat transfer with normal fluids ($0.5 < N_{Pr} < 100$) flowing in circular ducts. A cooling-effectiveness comparison showed tenfold- greater pumping power requirements for this salt than for a number of other molten salts and liquid metals. This, in combination with susceptibility to nuclear-radiation damage, indicates that the use of this nitrate-nitrite salt mixture may be limited to secondary cooling circuits or to the high-temperature, noncorrosive testing of simulated reactor systems. (auth)

**10578** OSR-TN-55-347
Maryland. Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics.
MAGNETOHYDRODYNAMICS AND MAGNETOGASDYNAMICS. S. I. Pai. Sept. 1955. 35p. Contract AF18(600)993. (BN-59; AD-74432).

The fundamental equations of magnetofluiddynamics are derived. For incompressible fluid magnetohydrodynamics, the important parameters are the Reynolds number $R_e$, the magnetic pressure number $R_H$, which is the ratio of magnetic pressure to dynamic pressure, and the velocity number $R_v$, which is the ratio of the fluid velocity to the characteristic velocity of which the magnetic field is moving through a conductor. Some exact solutions and properties of the equations of magnetohydrodynamics are given. Stability of laminar flow and turbulence in magnetohydrodynamics are briefly reviewed. Some magnetohydrodynamic experiments are described. For compressible fluid, magnetogasdynamics, the important parameters are still $R_e$, $R_H$, and $R_v$ plus other well known important parameters of ordinary gas dynamics such as Mach number, Prandtl number, and ratio of specific heats. Both the waves of small amplitude, Alfvén's waves in compressible fluid, and shock waves in magnetogasdynamics are discussed. (auth)

**10579** WAPD-V(FBE)-25
Vitro Engineering Co., New York.
COMPILATION OF CURRENT WORK IN TRANSIENT BOILING. Report No. 1. S. K. Hellman and R. W. Kupp. 1958. 12p. For Westinghouse Electric Corp. Bettis Atomic Power Div. Subcontract 73-(14-1025). OTS.

A report on progress of work related to boiling bubble dynamics is presented. The information presented was obtained primarily from investigators working in the field of heat transfer and hydraulics. Tabular summaries of work are included along with a list of all papers noted by investigators. (J.R.D.)

**10580** TID-5670
Columbia Univ., New York. Engineering Research Labs.
INITIAL EXPERIMENTS ON PRESSURE DROP FOR FLOW THROUGH ECCENTRIC ANNULI. Technical Note IX TN-1-59. PARTS I AND II. T. Diskind, C. A. Matos, and R. P. Stein. Nov. 20, 1959. 44p. Contract AT(30-1)-187. OTS.

The results of initial experiments on pressure drop in concentric and eccentric annuli with eccentricities up to 90% and a radius ratio of 1.5 are reported. The friction factor is correlated as a function of Reynolds number and eccentricity for both smooth and rough annuli. (W.L.H.)

**10581**
THERMAL CONDUCTIVITY OF PACKED BEDS. William Schotte (E. I. du Pont de Nemours & Co., Wilmington, Del.). A.I.Ch.E. Journal 6, 63-7(1960) Mar.

A correlation was developed to predict the thermal conductivity of packed beds for various conditions of pressure, temperature, and particle size. The correlation takes into account the reduction in thermal conductivity of the gas phase at lower pressures when the mean free path of the gas molecules is of the same order as the distance between particles which are effective in transferring heat. Radiation becomes significant for large particles and high temperatures. A relationship for the radiation contribution to the thermal conductivity of packed beds was developed. (auth)

**10582**
STUDIES OF HEAT TRANSFER NEAR WALL SURFACE IN PACKED BEDS. Sakae Yagi and Daizo Kunii (Univ. of Tokyo). A.I.Ch.E. Journal 6, 97-104(1960) Mar.

From studies of annular packed beds wherein the heat flows purely radially, the coefficients of heat transfer on the inner tube surface and the mean effective thermal conductivities of the bed were determined. The inner and outer diameters of the annular packed bed were 22 and 70 mm respectively. The wall film coefficients obtained with air flowing axially through the bed were correlated for $N_{ReM} < 600$. The coefficients of heat transfer for cylindrical packed beds were correlated, with 0.054 used for values of $\alpha_\omega$ in the range $N_{ReM} < 2,000$. An equation was derived, which can be used for the prediction of the wall film coefficient in packed beds. (auth)

**10583**
PARTICLE IMPACTION ON SPHERES AT HIGH MACH NUMBERS. S. K. Friedlander (Johns Hopkins Univ., Baltimore). ARS Journal, 296-8(1959) Apr.

At high Mach numbers a detached shock wave is established upstream of the forward stagnation point of a blunt body. The equations of motion of a small particle in such a flow are set up, and deposition at the forward end by impaction is considered. An expression is derived for the impaction parameter, defined as in subsonic flow, at which the efficiency vanishes. This is applied to the high Mach number flow around a sphere, and it is found that the critical impaction parameter varies from 0.153 to 0.29 for density ratios from 4 to 14. A sample calculation is given. (auth)

**10584**
BURN-OUT HEAT FLOW DURING FORCED CONVECTION OF FLUIDS IN CHANNELS. A. A. Ivashkevich. Atomnaya Energ. 8, 51-4(1960) Jan. (In Russian)

Critical burn-out heat flow $q_c$ is studied at the point where nucleate boiling is replaced by film boiling. Various experimental data are generalized and an equation for determing the $q_c$ was derived. (R.V.J.)

**10585**
HEAT-TRANSFER OF HEAVY LIQUID METALS IN TURBULENT FLOW. M. H. Ibragimov, V. I. Subbotin, and P. A. Ushakov. Atomnaya Energ. 8, 54-6(1960) Jan. (In Russian)

Experiments were carried out with mercury, lead, and eutectic lead–bismuth alloy (43.5% Pb + 56.5% Bi). The mean heat transfer factors for mercury were determined at a point 60 diameters from the entrance. Preliminary hydrodynamic stabilization appeared at 40 diameters. Data for lead and lead–bismuth alloy were taken at 33 diameters from the heating point and 41 diameters from the tube entrance. The results are plotted on the basis of similarity criteria. The data are in good agreement with the approximation formula $Nu = 4.5 + 0.014\ Pe^{0.8}$. Admixtures of Mg did not affect the mean heat transfer factors of Pb–Bi alloy. (R.V.J.)

**10586**
MEASURING FLUID VELOCITY BY NUCLEAR RESONANCE. J. R. Singer (Univ. of California, Berkeley). Electronics 33, No. 14, 77-8(1960) Apr. 1.

A system for the measurement of fluid flow by nuclear magnetic resonance is described. Applications of the system are discussed. (C.J.G.)

**10587**
ON CONVECTIVE AND RADIATIVE INTERACTIONS IN ABSORBING MEDIUM. E. A. Sidorov. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Mekh. i Mashinostr. No. 5, 134-6(1959) Sept.-Oct. (In Russian)

A further analysis is made of a previously developed approximation which reveals more complicated conduction-radiation interaction characteristics than those described by a simple law of additivity. A stationary plane movement of incompressible liquid (with constant physical characteristics) near a non-isothermal surface is considered. (R.V.J.)

**10588**
DYNAMIC RESPONSE AND CONTROL OF MULTIPASS HEAT EXCHANGERS. Masami Masubuchi (Yokohama National Univ., Japan). J. Basic Eng. 82, 51-65(1960) Mar.

The transfer functions obtained by dynamic analysis of one shell pass and 2, 3, 4, . . ., 2n, 2n + 1 tube-pass heat exchangers as a distributed parameter system are presented in dimensionless forms. The heat-exchange processes were found to be governed by the third-order characteristic equations with complex coefficients, and can be solved numerically using a graphical method. The numerical examples are presented to show the clear difference of frequency response for such cases when no solid capacity exists. The analog computer and the experimental results are found to be in good agreement with the theoretical results. (auth)

**10589**
CRITICALITY PROBLEMS IN CHEMICAL PLANT DESIGN. G. R. Hall (Imperial Coll., London). Nuclear Power 5, No. 45, 118-21(1960) Jan.

The basic factors in criticality control are discussed. It is shown how they affect the design of geometrically safe equipment and chemical plants. Experiments at Dounreay on the influence of materials used in processing fuels and some dangers in typical processes are described. The criticality accident at Oak Ridge in 1958 is discussed and the essentials of nuclear safety organization are outlined. (auth)

## Instrumentation

**10590** AEEW-M-10
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England.
DIODE RESPONSE AND TIME DERIVATIVE OF RESPONSE TO AN EXPONENTIALLY INCREASING INPUT CURRENT. J. D. Cummins. Oct. 1959. 11p. BIS.

Equations are derived for the response and time derivative of response of a diode to exponentially increasing input current. Numerical results are presented in tabular form. (C.J.G.)

**10591** AERE-M-593
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE PREDICTION OF THE PERFORMANCE OF AN ELECTROSTATIC PRECIPITATION WIRE MACHINE USING FISSION PRODUCT DATA. P. Barr and L. G. Ralfe. Dec. 1959. 30p.

A theoretical analysis of the behavior of an electrostatic precipitation wire machine is presented. Curves based on the theoretical predictions and previously published experimental data on the fission products of uranium are compared to enable estimates to be made of the performance of fission product measurement systems. Good agreement was obtained between theoretical and experimental results. Details of experimental checks on the validity of the theoretical analysis are given. (auth)

**10592** ANL-6123
Argonne National Lab., Lemont, Ill.
TRANSISTOR SCINTILLATION SPECTROMETER. Michael G. Strauss. Feb. 1960. 28p. Contract W-31-109-eng-38. OTS.

The equipment described is an a-c operated portable scintillation spectrometer consisting of a preamplifier, a linear pulse amplifier, a single-channel pulse-height analyzer, a linear count-rate meter, a scaler, and a high-voltage power supply. The operation and performance of the circuits are discussed. The instrument is accurate and reliable, light in weight, and consumes low power. (auth)

**10593** ARF-1151-4
Illinois Inst. of Tech., Chicago. Armour Research Foundation.
MAGNETIC RECORDER FOR NUCLEAR PULSE APPLICATION. Period covered: December 6, 1959 to February 5, 1960. G. M. Burgwald and R. M. Norton. Feb. 24, 1960. 8p. Contract AT(11-1)-702. OTS.

An evaluation of a modulator flux sensitive playback head to be used with an analog magnetic recorder for nuclear pulse information storage was made. The modulator head was found unsuitable. A pulse stretching unit was constructed which takes pulses from a standard linear pulse amplifier and provides an output signal suitable for driving a recording head. (For preceding period see ARF-1151-3.) (C.J.G.)

**10594** CNI-28

Italy. Comitato Nazionale per le Richerche Nucleari. Centro di Studi Nucleari, Ispra.
IMPULSI DI NEUTRONI PRODOTTI DA UNA FENDITURA RUOTANTE EFFETO DEI BORDI. (Neutron Pulses Produced by Rotating Slit Edge Effect). C. Coceva and B. Faleschini. Dec. 1959. 27p.

Symmetrical slits of different design for a fast neutron chopper are compared. Calculations are carried out in order to obtain the shapes of the pulses, their widths at half maximum, the cut-off function, and overlapping, taking into account the actual transmission of the materials of the chopper rotor. Particular attention is given to the edge effect, due to the neutrons that cross the material. A new slit design, with improved characteristics, is suggested. (auth)

**10595** CREL-902

Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.
THE SEMICONDUCTOR DIODE RING MODULATOR AS AN INPUT ELEMENT TO A DC AMPLIFIER. C. G. Lennox. Jan. 1960. 17p. (AECL-977). AECL.

A diode ring modulator is described, its performance evaluated, and its application to the measurement of small currents discussed. (T.R.H.)

**10596** CU-198

Columbia Univ., New York. Pupin Cyclotron Lab. and Columbia Univ., New York. George B. Pegram Lab.
A 2000 CHANNEL ANALYZER FOR NEUTRON SPECTROSCOPY. J. Hahn and W. W. Havens, Jr. Nov. 1, 1959 42p. Contract AT-30-1-GEN-72. OTS.

A 2000-channel neutron time-of-flight analyzer is described. Each channel has a time width which can be varied from 0.1 to 0.8 μsec. The instrument utilizes a fast electrostatic memory system in conjunction with a slow magnetic drum memory. The electrostatic memory system is described. (C.J.G.)

**1059** JPL-EP-635

California Inst. of Tech., Pasadena. Jet Propulsion Lab.
RADIATION INSTRUMENT USED IN LUNAR PROBES. C. Josias. May 3, 1959. 16p. Contract NASw-6.

The radiation measurement device is described which was used in the JUNO-II lunar probe of March 3, 1959. Pulses from a Type 302 Geiger tube are processed through a trigger amplifier and then counted in a scalar from which multiple digital outputs are mixed and fed to a subcarrier oscillator. Current pulses from the Type 213 Geiger tube are integrated in an R-C filter and the average voltage thus formed is fed to a second sub-carrier oscillator through a high-input impedance unity voltage gain power amplifier. The resultant voltage change at the output of the amplifier or frequency shift of the subcarrier oscillator is an analog representation of the radiation intensity. (T.R.H.)

**10598** LA-2375

Los Alamos Scientific Lab., N. Mex.
LIQUID SCINTILLATOR RADIATION RATE METERS FOR THE MEASUREMENT OF GAMMA AND FAST NEUTRON RATES IN MIXED RADIATION FIELDS. D. L. Williams, F. N. Hayes, R. L. Schuch, R. L. Crawford, and R. D. Hiebert. Nov. 1, 1959. 59p. Contract W-7405-eng-36. OTS.

A system of "paired" liquid scintillator rate meters for the measurement of gamma and fast neutron rates in a mixed radiation field is presented. The preparation and calibration of photovoltaic cell (high dose rate) meters and photomultiplier tube (low dose rate) meters are described. The over-all range of these devices is from about $10^{-5}$ to $10^5$ roentgens per minute. Various factors which affect the performance of these meters are discussed. (auth)

**10599** NP-8402

Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw.
OPTIMALE REGELUNGSSYSTEME (ZEIT-OPTIMALE REGELUNGSSYSTEME). (Optical Control System (Time-Optimum Control System)). Report No. 122. P. J. Nowacki. Nov. 1959. 26p.

Time-optimum control systems are described with respect to systems of the second order. These systems are of interest, above all, for sequential systems and have the aim of making the operational values equal to the control values in a minimum time. The theory of time-optimum control systems, the switching function, the shape of the phase curve, and the engineering construction of a time-optimum control system of the second order are considered. (J.S.R.)

**10600** NP-8475

Cornell Univ., Ithaca, N. Y.
THE PERFORMANCE OF A Be-Cu PHOTOMULTIPLIER IN THE 100A-300A REGION. Technical Report No. 3. D. H. Tomboulian. Feb. 1960. 29p. Contract Nonr-401(37).

A description is given of the performance and reliability of a Be-Cu photon counter which was satisfactory in determining absorption coefficients in the 100 to 300 A spectral range. (T.R.H.)

**10601** OOR-2211.1

Pittsburgh. Univ. Sarah Mellon Scaife Radiation Lab.
LOW ENERGY NUCLEAR AND ELECTRON PHYSICS. MULTI-MODE CHARGED PARTICLE ANALYZER. Technical Report No. II. Lorne A. Page. 1959. 49p. DA Project No. 599-01-004. Contract DA-36-034-ORD-2765.

An analyzer for ions or electrons having momentum per unit charge ranging up to one or two million volts/c and based on cylindrical geometry with a homogeneous magnetic field throughout the apparatus parallel to the axis of symmetry is considered. It is calculated that point to point focus with reasonably good aperture can be had by introduction of a radial electric field over a certain intermediate region, thereby having a crossed-field selection operating in the common magnetic field. A number of possible modes of operation are discussed, including those applicable to momentum spectrometry, to specific charge sorting, and to recognition of kinematically special knock-on electrons. Non-relativistic calculations are carried through second order, neglecting fringing electric fields, for the case of a specific momentum-analyzer mode. Relativistic results are discussed (to all orders in $v^2/c^2$) which indicate that, as energy changes, a correspondingly mild adjustment of length parameters would be required to preserve a given mode. Time of flight is computed from source point to focal point, as is the amount of spin precession relative to velocity precession. (auth)

**10602** ORNL-2793

Oak Ridge National Lab., Tenn.
CALIBRATION AND TESTING OF 2- AND $3\frac{1}{2}$-IN. MAG-

NETIC FLOWMETERS FOR HIGH-TEMPERATURE NaK SERVICE. R. G. Affel, G. H. Burger, and C. L. Pearce. Mar. 4, 1960. 76p. Contract W-7405-eng-26. OTS.

High-temperature calibration tests were made on 12 magnetic flowmeters of 2-in. sched-40 pipe size and 12 magnetic flowmeters of $3^1/_2$-in. sched-40 pipe size with NaK as the flow medium. Ten of each type of unit were calibrated against a venturi water-calibrated to an accuracy of 0.25%, over periods of operation to 3000 hr. The two remaining units of each type were not operated, but the magnet air gap flux density was monitored to detect changes for comparison with the operated units. The results of the calibration are tabulated and discussed. Background material on magnetic flowmeter application, design, and theoretical principles from the literature is included. (auth)

**10603** SCTM-44-60(12)
Sandia Corp., Albuquerque, N. Mex.
ZEUS CONTROL SYSTEM. A. E. Binder. Feb. 15, 1960. 21p. OTS.

A description of the control circuitry of the Zeus Capacitor Bank installed at Los Alamos is presented, along with a brief outline of some of the design considerations of the Zeus system. (auth)

**10604** SCTM-46-60(13)
Sandia Corp., Albuquerque, N. Mex.
IGNITRON RESISTANCE DURING HIGH-CURRENT OPERATION. J. L. Todd. Feb. 26, 1960. 21p. OTS.

A definition of average conduction resistance for an ignitron is established, and a test bank for determining the value of this resistance is described. Data are reported on four typical ignitron types for several currents in the kiloampere range. Oscillograms are presented to illustrate the change of current with time for a conducting ignitron in a ringing circuit. (auth)

**10605** SCTM-381-59(16)
Sandia Corp., Albuquerque, N. Mex.
A METHOD FOR DETERMINING THE CURIE LOADING OF $Kr^{85}$ IN NUCLEAR BATTERIES. Alex Thom. Jan. 8, 1960. 16p. OTS.

A calorimeter was developed for determining the amount of $Kr^{85}$ in a nuclear battery. The construction of the calorimeter is described, and a sample measurement is included. (auth)

**10606** TID-3549
Technical Information Service Extension, AEC.
REMOTE-CONTROL EQUIPMENT. A Literature Search. Henry D. Raleigh, comp. Mar. 1960. 22p. OTS.

Included are 149 references on remote-control equipment used in operations that take place under highly radioactive conditions. The majority of the references pertains to equipment used in hot laboratories, but also covered are reactor fuel element handling equipment, nuclear aircraft maintenance equipment, and servomechanisms. (auth)

**10607** TID-5623
FXR, Inc., Woodside, N. Y.
FINAL REPORT [ON MILLIMETER WAVE COMPONENTS]. Lester L. Bertan. July 20, 1959. 30p. For Univ. of Illinois. Contract AT(11-1)-663. OTS.

The development of a series of 2 millimeter wave components is summarized and the results of measurements are given. Components included waveguides and flanges, crystal multiplier, crystal detector, bolometer, adjustable shorts, VSWR measuring device, frequency meter, tapered transitions, horns, variable phase shifters, mode converter, power dividers, bends and twists, termination, and attenuator. (W.D.M.)

**10608** TID-7571(p.133-45)
Kansas State Coll., Manhattan.
SPECIAL COUNTERS FOR NUCLEAR RADIATION DETECTION. Robert W. Kiser. 13p.

The external cathode counter is discussed in terms of it operation, its similarities to the usual counters, its distinguishing characteristics, as plateau length and equivalent circuit, and its use as a detector of nuclear radiation Because of its special characteristics, the Maze counter was a logical choice for use at elevated temperatures, and such extensions in application to high temperature proportional counting are described. In particular, it is shown that the ethane high-temperature proportional counter, over a range of 120 to 360°C, gives results identical to those observed by usual methods. Similar results have been obtained for carbon dioxide-argon proportional counters. The limitations of these counters and the reasons for such limitations are discussed. (auth)

**10609** TID-7571(p.177-86)
Kansas. Univ., Lawrence.
A HIGH LEVEL RADIATION POLYMERIZATION DOSIMETER. Frank E. Hoecker. 10p.

A new type of radiation dosimeter designed for industrial and other applications requiring a go, no-go device, or one which indicates the dose between certain limits, is described. The dosimeter uses photochemical reactions which lead to infinite network formation (gel formation) in a dosimetric liquid. Dosimetric cells have been prepared for any desired dose between $10^4$ and $10^7$ rads by suitably altering the composition of the liquid. The device is expendable and therefore cheap, the end-point is irreversible, the device may be made very small, it requires no auxiliary equipment for reading, and may be read by anyone who has normal vision. (auth)

**10610** TID-7571(p.209-28)
Ohmart Corp., Cincinnati.
PROCESS CONTROL WITH GAMMA RADIATION GAUGES. P. E. Ohmart. 20p.

Methods of using radioactivity density gages to measure and control processes incorporating evaporators, raw mills, and thickeners are described. The development of a radioactivity density gage is outlined from absorption curves through to a complete unit consisting of source, cell, compensating cell, amplifier, and recorder and/or controller. Methods for using the same technique for level measurement are outlined, together with a number of examples of systems depending upon the precision required and the measuring range. (auth)

**10611** TID-7578(p.49-59)
Los Alamos Scientific Lab., N. Mex.
ADVANCES IN LIQUID SCINTILLATION COUNTING. D. G. Ott. 11p.

The various components of liquid scintillator counting systems and some of their properties and uses are discussed. Applications in small-volume internal-sample counting and large-volume, external-sample counting are described. (C.H.)

**10612** UCRL-9046
California. Univ., Berkeley. Lawrence Radiation Lab.
DESIGN LIMITATIONS OF A BREAKDOWN DIODE COUPLED TRANSISTOR FLIP FLOP (thesis). Thomas Archie Nunamaker. Jan. 1960. 57p. Contract W-7405-eng-48. OTS.

It is well known that the output characteristics of collector coupled transistor flip flops (Eccles Jordan type of circuit) may be stabilized by the addition of clamping diodes to the output circuit. The work presented shows that with a saturating type of flip flop this same clamping action may be accomplished with a single double-base breakdown-diode placed between the collectors of the two transistors. The advantage of such a method of clamping lies in its simplicity, as only three solid state components are necessary; one double-base breakdown-diode and two transistors. The switching time of such a flip flop is comparable with other types of saturated flip flops as the type of clamping has little effect upon switching time. The noise generated by breakdown-diodes ranges from a few m.v. to a few hundred m.v., and is considerably greater than the noise generated by a standard diode. Consequently breakdown-diode clamping should not be used where noise is likely to be a serious problem. (auth)

**10613** USNRDL-TR-379
Naval Radiological Defense Lab., San Francisco.
A SYSTEM FOR TRANSLATION OF PULSE TYPE MAGNETIC TAPE DATA INTO GRAPHICAL OR DIGITAL INFORMATION. W. J. Gurney. Sept. 22, 1959. 39p.

A system designed to provide the reduction of recorded pulse type magnetic tape data of gamma radiation and time into digital or graphical form is described. The basic operation consists of accumulating radiation data pulses for selected short intervals of recorded field time to determine the radiation rates, and to determine the total dose through accumulation of these pulses for extended pericds. These operations are compared with the integration of recorded field time to achieve either dose rate or total dose histories of the gamma events. The output information is either printed-out on paper tape or converted into analog voltages for semi-automatic plotting. Accuracies are in the order of 90 ± 10% for the analog conversion and errors are within ±0.5% for the digital print-out methods. (auth)

**10614** USNRDL-TR-394
Naval Radiological Defense Lab., San Francisco.
INSTRUMENTATION AND REMOTE CONTROL SYSTEM FOR GROUND-TO-AIR ATMOSPHERIC TRANSMISSION MEASUREMENTS. R. Rudkin. Dec. 28, 1959. 25p.

Ground-to-air atmospheric transmission measurements were made from an aircraft at altitudes of from 2000 to 20,000 ft and slant ranges up to 63,000 ft. The instrumentation required for the remote control of the ground station from the aircraft as well as the control operations on the aircraft itself are described. A detector indicating circuit in the aircraft showed which of the four possible detector arrays was used in the acquisition of any set of data by intensity modulating the traces on oscilloscopes. The remote control system makes use of the transmission of two audio tones, one for operating the radiation source and the other for securing it. These tones are transmitted by means of a radio link made up of two AN/ARC-27 transceivers. (auth)

**10615** WADC-TR-59-107
Consolidated Electrodynamics Corp., Pasadena, Calif.
A MASS SPECTROMETER SYSTEM FOR MATERIALS RESEARCH SUMMARY REPORT, PHASE I. Period covered: April 1, 1958 through January 1959. Charles F. Robinson, George D. Perkins, and Norton W. Bell. Feb. 1959. 30p. Project title: MATERIALS ANALYSIS AND EVALUATION TECHNIQUES. Task title: MOLECULAR AND ATOMIC STRUCTURAL ANALYSIS. Contract AF33(616)-5571. (AD-216714; PB-161073). OTS.

A report of progress during the first phase of research and development on a high-performance mass resolving system for research on trace impurities in solid structure is presented along with thermodynamic studies of high boiling (1000°C) materials and identification of unknowns by determination of molecular weight. (auth)

**10616** WT-784
Naval Ordnance Lab., White Oak, Md.
EVALUATION OF WIANCKO AND VIBROTRON GAGES AND DEVELOPMENT OF NEW CIRCUITRY FOR ATOMIC BLAST MEASUREMENTS. Joseph Petes, C. C. Little, and J. L. Dossey. Feb. 1955. 56p. Project 1.1a-1 [of] OPERATION UPSHOT-KNOTHOLE. (NOLR-1181). OTS.

Experimental instrumentation was tested on Operation Upshot-Knothole in an endeavor to improve existing blast phenomena measuring equipment and techniques. Experimental designs tested include a field unit oscillator-amplifier using transistor circuit elements, a subminiature two-wire field unit, a commercially developed Vibrotron gage and amplifier unit, and a frequency deviation multiplier circuit for obtaining increased signal-to-noise ratios. The Wiancko pressure gage was also evaluated more fully. The results of the tests are described. Transistor circuitry was found to be little affected by atomic blast phenomena. (M.P.G.)

**10617** WT-785
Naval Ordnance Lab., White Oak, Md.
DEVELOPMENT OF MECHANICAL PRESSURE-TIME AND PEAK PRESSURE RECORDERS FOR ATOMIC BLAST MEASUREMENT. F. J. Oliver, R. R. Caforek, H. R. Smith, and W. E. Morris. Mar. 1955. 36p. Project 1.1a-2 [of] OPERATION UPSHOT-KNOTHOLE. (NOLR-1182). OTS.

Two mechanical air blast gages are described. The successful modification, field use, and evaluation of an indenter gage for the measurement of peak pressure is described. This gage is fully damped and has a response time of from 3 to 5 msec in the pressure range from 1 to 250 psi. Under appropriate shock conditions reliable pressure values accurate to within ±5% were obtained under field conditions when acceleration effects were eliminated by proper mounting. The design and field performance of a new self-contained pressure-time recorder is also described. The sensing element is a sylphon bellows, and the shock pressure is recorded on a smoked-glass plate attached to a sliding table. A one hundred cycle timing signal, regulated by a stop watch, is recorded. Six gages were constructed having response times of 2 and 5 msec and pressure ranges of 25 and 60 psi. When acceleration effects were eliminated by firmly mounting the gage, good records were obtained which were accurate to ±0.25 psi. (auth)

**10618** NP-tr-407
SEMICONDUCTOR DEVICES AND THEIR APPLICATIONS. (Poluprovodnikovye Pribory I Ikh Primenenie). A translation from the Publishing House of Soviet Radio, Moscow, 1957. 603p. OTS.

A collection of 36 papers is presented relating to the properties and peculiarities of crystal triodes and to the problems of their application in electronic instrumentation. The papers cover the following subjects; physical fundamentals and operational principles, miniature components for transistor circuitry, properties, temperature characteristics and temperature compensating methods, and transistor circuits. (W.L.H.)

**10619**
AN AXIAL RETIGRAPH. A. L. Mackay (Birkbeck Coll., London). Acta Cryst. 13, 240-5(1960) Mar. 10.

A retigraph, an x-ray-diffraction camera which records on film an undistorted projection of one plane of the reciprocal lattice of a crystal, was constructed. The mapping of the remainder of the reciprocal lattice on to the film plane is analyzed together with other aspects of the camera geometry which also applies to the precession camera. The Lorentz and polarization corrections, both for polarized and unpolarized incident radiation, are calculated. Methods of setting such instruments employ characteristic spots or Laue streaks. (auth)

**10620**

BEHAVIOR OF OPEN AIR POINT COUNTERS AT HIGH TEMPERATURES. T. Lewowski and B. Sujak (Institut für Experimentalphysik, Universität, Wrocław, Poland). Acta Phys. Polon. 18, 411-18(1959). (In German)

An easily heatable open-air point counter was constructed. The behavior of counters at temperatures between 20 and 500°C was studied. It was found that by simple thermal means the working voltage of air point counters can be lowered about 30%. The air point counter was also operated in the continuous discharge region and its behavior at 20 to 500°C studied. It was found that the corona-producing point counter (spark counter) which responds to $\alpha$ particles is completely independent of the vapor content of the air above 100°C. The counter exhibits a long, flat plateau at its working characteristic and a very small operating potential which at 450°C is near 2300 v. (tr-auth)

**10621**

THE INTEGRATING DETECTOR OF PENETRATING RADIATION. O. A. Myazdrikov. Atomnaya Energ. 8, 64-5(1960) Jan. (In Russian)

According to B. Gross (J. Chem. Phys 17, No. 10, 866(1949)) the electret state of a dielectric is described by the bound volume and real charge density, with corresponding surface densities. Considering that the total charge density value is derived by measuring the surface charge density on the basis of an electrostatic induction principle, it is possible to assume that $\sigma_f + \sigma_r = \rho_n'$, where $\rho_n'$ is the normal component of equivalent electric moment of the dielectric unit volume. The influence of penetrating radiation on the electret state is studied (with a specially designed detector) in order to determine the regularity in surface variations. The variability of frozen polarization serves as a measure of dose recording and the electret acts as a radiation integrator. The detector sensitivity determined for $\gamma$ and neutron fluxes can be controlled by the variation of the factors. (R.V.J.)

**10622**

THE EFFICIENCY OF A GAS DISCHARGE COUNTER. V. P. Bovin. Atomnaya Energ. 8, 68-70(1960) Jan. (In Russian)

The efficiency of counters with various filler gases is studied as a function of radiation energy. Tests were made with MC and BC argon—alcohol filled counters with copper and tungsten cathodes sprayed on the inner wall, GS counters with graphite cathodes, and halide counters with steel cathodes. The MC and GS possessed higher quantitative efficiency but required high working potentials (1300 to 1350 v). The BC type counters have high integral efficiency due to the high tungsten cathode photoabsorption factor. The efficiency curves are plotted. (R.V.J.)

**10623**

AN AIRCRAFT RADIOMETER-ANALYZER. V. V. Matveev and A. D. Sokolov. Atomnaya Energ. 8, 70-2 (1960) Jan. (In Russian)

The high sensitivity of a liquid scintillator threshold $\gamma$ spectrometer designed for determining the intensity of relatively hard $\gamma$ radiation emitted from the ground is described. (R.V.J.)

**10624**

MEASURING RADIATION WITHIN HUMAN BODY. S. J. Malsky, C. Amato, C. Spreckles, B. Roswit, and C. Reid (Bronx Veterans Administration Hospital, Bronx, N. Y.). Electronics 33, No. 12, 74-5(1960) Mar. 18.

A procedure is given for measuring radiation received by the human body. Glass dosimetry needles are used which fluoresce in proportion to the amount of radiation received. The fluorescence is detected by a photomultiplier, amplified by an electrometer, and then converted to dosage. The accuracy of the dosimeter over a limited energy range is 4 to 5%; the linearity extends to 10,000 rads. (B.O.G.)

**10625**

A SIMPLE METHOD OF MINIMIZING THE ENERGY DEPENDENCE OF POCKET IONIZATION CHAMBERS. F. W. Sanders, J. A. Auxier, and J. S. Cheka (Oak Ridge National Lab., Tenn.). Health Phys. 2, 308-9(1960) Feb.

The use of a 0.040-in. tin filter, or sleeve, over 3.5-cm length of the charging end of a pocket ionization chamber permits use over a wide range of energies. Data are presented on the response of such modified chambers to cesium-137 and cobalt-60 gamma sources and x radiation. (C.H.)

**10626**

THE PRINCIPLES OF MECHANICAL NEUTRON-VELOCITY SELECTION. R. D. Lowde (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. A, Reactor Sci. 11, 69-80(1960) Feb. (In English)

The term 'velocity selection' is used in the strict sense in which a mechanical selector is a machine that rejects from a beam all neutrons with velocities outside some more or less narrow range. The principle is that of chopping the beam twice in succession, at two different points separated by a flight path. A rationale is given of the design of such machines. For slow neutron studies a mechanical selector can be constructed whose maximum energy resolution in an experimental arrangement of given collimation is better than that of crystal diffraction equipment at wavelengths down to $\lambda_0$ = 1Å, but which is more flexible than the crystal instrument in that a greater range of values of $d\lambda_0/\lambda_0$ can be provided. A quantity called the transmittivity is defined, and it is shown that both transmission and resolving power of an idealized velocity selector are independent of the absolute scale of the instrument. A procedure is given for fixing the parameters in a practical case, and various types of selector are analyzed in detail. (auth)

**10627**

EXPERIMENT ON THE UTILIZATION OF A PURE NaI CRYSTAL AS $\gamma$ DETECTOR IN RAPID COINCIDENCE. Michel Vergnes and Raymond David-Boyer (Laboratoire de Physique Nucléaire, Orsay, France). J. phys. radium 21, 65-7(1960) Jan. (In French)

The possible utilization of pure NaI crystals in a fast coincidence system as $\gamma$ detectors for low-energy photons is investigated. The crystal used is 20 mm in diameter and 4 mm in thickness. As it must be cooled to the temperature of liquid nitrogen, a light conductor is necessary to prevent cooling the photocathode. The mounting of the crystal is described. The $\gamma$ spectra of $Cs^{137}$ and $Gd^{153}$ are used to determine the resolution obtained, which is less than that obtained with NaI(Tl). The decay time of the pure crystal is shorter. These results show no significant improvement from the utilization of pure NaI crystals. (J.S.R.)

**10628**

INTRODUCTION TO THE CONSTRUCTION OF DISCRIMINATOR CIRCUITS. Jürgen Schulz (Telefunken-Forchungsinstitut, Ulm, Ger.). Kerntechnik 2, 53-7(1960) Feb. (In German)

An introduction to the performance of integral, differential, and multi-channel discriminators is given. Examples of circuits and typical problems are discussed with respect to integral discriminators and differential discriminators. The principles of the wave discriminators and the analog digital transformer are reviewed in the discussion on multi-channel discriminators. (tr-auth)

**10629**

A LABORATORY HIGH-VACUUM FURNACE FOR USE AT TEMPERATURES UP TO 1,500°C. G. T. Poyner (B.S.A. Group Research Centre, Birmingham, Eng.). Metallurgia 61, 48(1960) Jan.

A description is presented of a laboratory-type high-vacuum furnace for operation at temperatures up to 1,500°C. A variation of ±3°C is obtained over the 3-in. central zone. A vacuum of better than 0.1 micron can be attained. (B.O.G.)

**10630**

LOW LEVEL ALPHA COUNTING AND TECHNIQUES. John H. Pingel (Argonne National Lab., Lemont, Ill.). Nondestructive Testing 18, 131-5(1960) Mar.-Apr.

A discussion of low-level alpha counting techniques is presented. In the lowest level work, counting rates of one tenth to several counts per hour are involved. Several uses for alpha radiation and the techniques used in counting, as well as decontamination of the material, are discussed. The over-all method used in most low levels consists of gathering large samples; selecting, concentrating, and purifying the radioactivity; preparing a mounted sample; counting the sample; and standardizing the entire process. (B.O.G.)

**10631**

THE SPHERICAL CONDENSER AS A HIGH TRANSMISSION PARTICLE SPECTROMETER. I. POINT SOURCE. R. H. Ritchie, J. S. Cheka, and R. D. Birkhoff (Oak Ridge National Lab., Tenn.). Nuclear Instr. and Methods 6, 157-63 (1960) Jan. (In English)

The inverse square electric field between two concentric charged spheres provides a focusing of charged particles which leave a point source on the inner sphere. An analysis of the transmission, resolution, and line profile shape which may be obtained with a spectrometer utilizing this focusing was carried out analytically and graphically. It is found that the fractional transmission T is related to the resolution $\delta_{1/2}$ (the fractional energy spread at half the maximum transmission) according to $T = \sqrt{\delta_{1/2}}$. Transmissions as high as 25% are obtainable at 6% energy resolution with such a device. (auth)

**10632**

THE INPUT STAGE OF A TRANSISTOR PULSE AMPLIFIER. A. W. Pryor (Australian Atomic Energy Commission, Lucas Heights, New South Wales). Nuclear Instr. and Methods 6, 164-8(1960) Jan. (In English)

The input signal of a linear amplifier for nuclear detectors is in the form of a charge released in very short time. Under these circumstances a transistor input stage behaves very differently from a valve input stage both in the shaping of the pulse and in the noise conditions. An experimental and semi-theoretical account of the performance of typical R.F. transistors is presented. (auth)

**10633**

ANGULAR SELECTIVITY OF A GEIGER TELESCOPE ARRANGEMENT FOR COSMIC RAY AIR SHOWERS. W. M. Layson, J. Malos, and D. D. Millar (Univ. of Sydney). Nuclear Instr. and Methods 6, 179-82(1960) Jan. (In English)

An arrangement of Geiger telescopes for the selection of vertical air showers was investigated. The arrangement shows little selectivity in responding to near-vertical showers. The experimental results are in good agreement with the calculated angular selectivity. The arrangement is not likely to be of great value in looking for anisotropy in the high energy primary cosmic radiation. (auth)

**10634**

A TWO-DIMENSIONAL PULSE-HEIGHT ANALYSER. A. E. Litherland and D. A. Bromley (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Nuclear Instr. and Methods 6, 176-8(1960) Jan. (In English)

A method is described whereby a 120-channel pulse-height analyzer can be converted into three forty-channel pulse-height analyzers. This is accomplished by adding three voltage pedestals of different height to the input pulses. The method was successfully used in a study of the $N^{14}(He^3p\gamma)O^{16}$ reaction. (auth)

**10635**

ON THE EFFECT OF TOTAL REFLECTION ON THE OPTIMUM DIMENSIONS OF COLLIMATORS FOR NEUTRON CRYSTAL SPECTROMETERS AND DIFFRACTOMETERS. P. Szabó (Central Research Inst. for Physics, Budapest). Nuclear Instr. and Methods 6, 183-6(1960) Jan. (In English)

An examination is made of the effect that is exercised by the total reflection developing at the walls of primary collimators used in neutron diffractometers and crystal spectrometers on the optimum dimensions of such collimators. The formulas for computation of the intensity transmitted by a single total reflection are given. It is shown that as to the intensity thus transmitted (similarly to the case of direct transmission) there is an optimum in the dimensions of the collimator which in cases of practical interest is found to be the same as that determined for direct transmission. (auth)

**10636**

A FAST COINCIDENCE UNIT OF VARIABLE RESOLVING TIME. J. B. Garg (The University, Manchester, Eng.). Nuclear Instr. and Methods 6, 187-92(1960) Jan. (In English)

A fast coincidence unit of variable resolving time in the range 0 to 100 ns is described. The unit is designed to accept pulses of either polarity and uses fast discriminators in order to select the amplitude of the input pulses. (auth)

**10637**

BEHAVIOUR OF PHOTOMULTIPLIERS AGAINST HIGH-FREQUENCY MODULATED LIGHT. C. Cernigoi, I. Gabrielli, and G. Iernetti (Università, Trieste, Italy and Istituto Nazionale di Fisicaà Nucleare, Trieste, Italy). Nuclear Instr. and Methods 6, 193-200(1960) Jan. (In English)

The frequency-response of several phototubes to light modulated in intensity by an ultrasonic device was examined. Frequency of light-modulation up to 48 Mc/sec was used. The method can be applied in order to select photomultipliers for fast-counting rates. (auth)

**10638**

A NEW SOLUTION OF THE FINITE RISE TIME PROBLEM BY MEANS OF A DISTRIBUTED AMPLIFIER WITH

AUTOMATIC GAIN CONTROL. B. Johansson (Nobel Inst. of Physics, Stockholm). Nuclear Instr. and Methods 6, 201-5(1960) Jan. (In English)

In a distributed amplifier the output pulse is built up by the addition of pulses from subsequent stages. If this sum-up is stopped when the pulses have reached a certain pulse-height level then the out-put pulses will have the same height and, what is essential in time measurements, the same shape independent of the height of the input pulse within a certain pulse-height range. A distributed amplifier based on this principle is described. It consists of 2 cascaded 5 tube amplifiers (rise-time 8ns) and covers a pulse-height range of 15 db. By a conveniently chosen combination of number of tubes and cascaded amplifiers, any desired pulse-height range can be covered. The amplifier can be built for fast as well as slow phosphors. (auth)

**10639**

EXCITATION OF EZ-10 COUNTER TUBES BY TRANSISTORS. P. F. Gutmann and D. T. Jovanovič (Centre d'Etudes Nucléaires, Saclay, France). Nuclear Instr. and Methods 6, 206-8(1960) Jan. (In French)

Described are two circuits suitable for the operation of counting tube type EZ 10. The first of these is a monovibrator supplied by a high voltage transformer and incorporates four transistors (PNP and NPN), and operates up to a frequency of 250 cps with small consumption. The second circuit is simpler, working on the principle of a blocking oscillator, the transformer of which has an additional high voltage winding; the upper limit of the frequency used (50 cps) is imposed by the maximum power dissipated in the transistor. (auth)

**10640**

A GAS ČERENKOV DETECTOR FOR THE ACCURATE DETERMINATION OF ELECTRON BEAM ENERGY. R. E. Jennings and P. I. P. Kalmus (University Coll., London). Nuclear Instr. and Methods 6, 209-12(1960) Jan. (In English)

Details are given of a variable pressure gas Čerenkov detector which is being used to measure the energy of the electron beam from the U. C. L. 4.5 Mev microtron. Nitrogen which has a Čerenkov threshold at a pressure of about 18 atmospheres for 4.5 Mev electrons is used, but many other gases would also be suitable. The detector is capable of giving an absolute value of the electron energy to an accuracy of about ±0.25%. (auth)

**10641**

ALUMINIUM OXIDE FILMS FOR NUCLEAR SPECTROSCOPY. K. Sevier, Jr. and W. Parker (Univ. of Uppsala). Nuclear Instr. and Methods 6, 218-19(1960) Jan. (In English)

A new method is presented for the preparation of aluminum oxide films for use in nuclear spectroscopy. This method is less tedious than the former in that only one side of the foil is oxidized rather than both sides. A diagram of the device which holds the foil while it is being oxidized is shown. (B.O.G.)

**10642**

ION CURRENT CHAMBERS USED IN THE CONTROL OF NUCLEAR REACTORS. Wacław Dąbek (Instytut Badań Jądrowych PAN, Warsaw). Nukleonika 4, 523-46(1960). (In Polish)

The principles of operation, design, and technology of neutron sensitive ionization chambers are discussed. A number of conditions which a chamber must fulfill are given. The possibility of extending the range of neutron flux which can be measured in the presence of a high gamma radiation background is discussed. (auth)

**10643**

A TRITIUM COUNTER DESIGNED FOR ROUTINE LABORATORY USE. Elizabeth Jones, J. R. Mallard, and C. J. Peachey (Hammersmith Hospital, London). Phys. in Med. Biol. 4, 253-63(1960) Jan.

An instrument for the rapid routine counting of tritium is described. It utilizes a liquid scintillator with coincidence circuitry, and incorporates a new fixed-cell design. An introductory analysis of the geometry of the system is made. The optimum counting efficiency of the counter for tritium in 25 ml of toluene-based scintillator is 25% with a background of 180 cpm. The use of the counter with tritiated water samples and with $C^{14}H^3$ mixtures is described. (auth)

**10644**

SOME NEW RADIATION MONITORS. B. W. Watson (Sheffield National Centre for Radiotherapy, Eng.). Phys. in Med. Biol. 4, 274-9(1960) Jan.

Two types of radiation monitor are described, which are of use in reducing the exposure of personnel in contact with radioactive substances. A pocket monitor for nurses working on radium wards is described which gives an audible indication when the dose-rate exceeds 30 mr per hour. A description is also given of a radiation level indicator which sounds an alarm when the radiation level at the apparatus exceeds a preset value. (auth)

**10645**

LARGE PROPORTIONAL COUNTER SPECTROMETER FOR THE STUDY OF RADIOACTIVE SAMPLES WITH LOW SPECIFIC ACTIVITY. J. T. Holloway, D. C. Lu, and D. J. Zaffarano (Iowa State Univ., Ames). Rev. Sci. Instr. 31, 91-5(1960) Feb.

The design and construction of a cylindrical proportional counter 36 in. long, 12 in. i.d. is described, and its performance as a spectrometer for studying soft radiations from radioactive samples of low specific activity is given. The counter tank is operated in an axial magnetic field of 2500 gauss to constrain beta rays to helical paths. A line width of 3.4% ($\Delta E/E$) is obtained for 625-kev electrons from a $Cs^{137}$ source mounted on a thin film placed within the tank. Simple theory would predict 2.2%. Beta spectra are readily obtained with sources having total activities less than 10 m$\mu$C. (auth)

**10646**

HIGH-SPEED BOLOMETER. H. E. Stubbs and R. G. Phillips (Allied Research Associates, Inc., Boston). Rev. Sci. Instr. 31, 115-18(1960) Feb.

A description is given of a high-speed bolometer intended for measuring the radiation from nuclear fireballs. The bolometer is made by successive depositions of an insulating layer and a gold sensing element upon a copper block which serves as a heat sink. An analysis of the bolometer's performance indicates that it has a response time of approximately 50 $\mu$sec. (auth)

**10647**

USE OF A PLATINUM FILAMENT IN THE ELECTRON MICROSCOPE. Francis W. Bishop (Univ. of California, Los Angeles). Rev. Sci. Instr. 31, 124(1960) Feb.

A platinum filament covered with a mixture of oxides was used to replace the tungsten filament in an electron microscope. Since the filament operates at a low temperature, evaporation of the filament itself is very slow. The electron source is very small. The drift of illumination is small and the field of illumination is quite uniform. (auth)

**10648**

FOLLOW-THROUGH PLATE HOLDER FOR NUCLEAR TRACK MICROSCOPES. A. E. Dyson (Univ. of California, Livermore). Rev. Sci. Instr. 31, 144-5(1960) Feb.

The use of a follow-through plate holder for following nuclear tracks from one emulsion plate to another is described. This is accomplished by placing one plate above the other in such a way that the upper plate may be moved horizontally together with the lower one or independent of it, while either is viewed in the microscope. (auth)

**10649**

DIGITRON, A DIGITAL TIME ANALYZER FOR MICROSECOND INTERVALS. R. A. Swanson (Univ. of Chicago). Rev. Sci. Instr. 31, 149-54(1960) Feb.

A system is described which measures microsecond time intervals by counting pulses from a 10-Mc ringing circuit. The data are accumulated in a magnetic core memory. The measured standard deviation of channel widths is $\leq 0.15\%$, and the drift in absolute time calibration is $< 0.1\%$ for periods of several days. (auth)

**10650**

SQUARE-WAVE GENERATOR FOR THE STUDY OF EXPLODING WIRES. T. J. Tucker (Sandia Corp., Albuquerque, N. Mex.). Rev. Sci. Instr. 31, 165-8(1960) Feb.

A 100-kv coaxial cable square-wave generator producing a 2000-amp, 3-μsec duration, 6-mμsec rise time, current pulse was constructed for the study of exploding wires. The circuit behavior is described by algebraic equations. Using coaxial-cable techniques for the entire system also provides mμsec resolution of current and voltage wave forms. The system features an output timing pulse, occurring $1.5 \pm 0.005$ μsec prior to the beginning of the wire explosion which provides triggering for oscilloscopes and for a 5-mμsec exposure time Kerr-cell camera. The electrical isolation of the output trigger pulse from the monitored signal also eliminates wave form distortion produced by trigger circuit loading and signal delay. (auth)

**10651**

EXPERIMENTAL CALIBRATION OF SCINTILLATION PULSE HEIGHTS OF THIN CsI CRYSTALS. D. C. Worth (International Christian Univ., Tokyo) and G. R. Haste (Univ. of Virginia, Charlottesville). Rev. Sci. Instr. 31, 169-70(1960) Feb.

The pulse-height response of three thin CsI crystals was determined for protons from $B^{10}(d,p)$ and $C^{12}(d,p)$ reactions, using Al foils to vary the energy of the incident protons. Three points on the range-energy curve for CsI were determined and compared with the range-energy curve for silver. (auth)

**10652**

SCINTILLATION-BUBBLE CHAMBER. Ralph C. Minehart and Richard H. Milburn (Havard Univ., Cambridge, Mass.). Rev. Sci. Instr. 31, 173-4(1960) Feb.

A solution of 33 g of naphthalene and 133 mg of PBD phosphor in a liter of liquid propane was found to perform as a liquid scintillation counter at temperatures of 65 to 75°C. This solution also functions comparably to pure propane as a bubble chamber filling. Scintillations were obtained from 100 to 145-Mev protons as well as from minimum-ionizing particles. This precludes Cherenkov radiation as the dominant scintillation mechanism, and shows that the processes of scintillation and bubble nucleation are compatible in the propane solution. Using a gated photomultiplier system, a number of chamber-scintillation-controlled photographs were made of cosmic-ray tracks. (auth)

**10653**

LIQUID-HELIUM GONIOMETER-MOUNTED CRYOSTAT FOR A SINGLE CRYSTAL AUTOMATIC NEUTRON DIFFRACTOMETER. S. C. Abrahams (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Sci. Instr. 31, 174-6(1960) Feb.

An all-metal cryostat capable of maintaining a single crystal at liquid helium temperatures is described. One filling of liquid helium lasts over 10 days. Crystal orientation is obtained by mounting the cryostat on a large goniometer head and tilting the entire cryostat to the required position. The maximum semi-vertical angle is 20°. The performance of the assembly for routine measurement of the diffracted neutron intensities from single crystals at ca 4.6 to 1.5°K is discussed. (auth)

**10654**

WIDE RANGE MARGINAL OSCILLATOR FOR OPERATING NUCLEAR RESONANCE PROBES THROUGH FLEXIBLE CABLE. L. Buss and L. Bogart (Stanford Univ., Calif.). Rev. Sci. Instr. 31, 204-5(1960) Feb.

A marginal oscillator circuit for operating nuclear resonance probes through a coaxial cable is described. Proton resonance in a field of 11,000 gauss was observed using 3 ft of flexible cable between oscillator and probe. Signal-to-noise ratios were about 30 to 1 using 0.5 cc of 0.02M $MnSO_4$ solution and 60 cps on the Helmholtz coils. The arrangement oscillates well between 25 and 90 Mc. (C.J.G.)

**10655**

METHOD FOR DETECTING NONPROPORTIONALITY OF RESPONSE FOR GAMMA-RAY SCINTILLATORS. R. W. Peelle and T. A. Love (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr. 31, 205-6(1960) Feb.

A quantitative method for studying the relation between the light output from a scintillator and the amount of absorbed gamma energy is described. Curves are presented showing the nonproportionality of response for the gamma cascade in the decay of $Bi^{207}$. (C.J.G.)

**10656**

METHOD OF MAKING FRISCH GRIDS. R. J. Watts (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr. 31, 213(1960) Feb.

A method for fabricating Frisch grids is presented. The method employs epoxy resins to fasten the grid wires to the ring while the ring has been slightly ellipticized with a spreader bar. After the resin has hardened, the removal of the spreader bar permits the ring to resume its circular shape thus putting a gentle tension on each grid wire to hold it straight. (C.J.G.)

**10657**

CALIBRATION OF LEAK DETECTION SPECTROMETER. R. Geller (Centre d'Etudes Nucléaires, Saclay, France). Vide No. 13, 3-14(1958) Jan.-Feb. (In French)

A study was made of the possible methods for calibrating a leak detection spectrometer, and the estimation of outputs from the leaks is considered. With this in mind the question of sensitivity of leak detection is tackled on a very general level; first the sensitivity of the isolated instrument is determined, and then the sensitivity of an instrument connected to an installation where leaks may be suspected. Finally, practical solutions are proposed. (auth)

**10658**

RING RESONATOR FOR RADIAL KLYSTRON. A. I.

Tereschenko and V. I. Milko. Zhur. Tekh. Fiz. 29, 1415-17(1959) Nov. (In Russian)

A design is given of a ring resonator formed by the convolution of a waveguide with a $\pi$-shaped cross section. (R.V.J.)

**10659**

DETECTEURS DE PARTICULES (COMPTEURS ET SCINTILLATEURS). MÉCANISME ET RÉALISATION. (Particle Detectors (Counters and Scintillators). Mechanism and Construction). Daniel Blanc. Paris, Masson et Cie, 1959. 326p.

A review is presented which is part of a college course. Previously recorded knowledge in other works on nuclear particle detection is omitted, with the discussion thus being limited to subjects which have not been made the object of complete studies: glass-walled Geiger-Mueller counters, halogen and pure-vapor counters, spark detectors, electric conductivity, life-time, and temperature coefficient. For the theory involved, several other works are recommended. In the first chapters, the general scheme of gas-ionization detectors is discussed. The other chapters cover luminous-signal detectors, scintillators, Cherenkov counters, and photomultipliers. In an appendix, tables and graphs are given of much useful data with references to the extensive bibliography included. (About 1,000 references). (T.R.H.)

**10660**

IMPROVEMENTS IN OR RELATING TO PORTABLE RADIATION DOSIMETERS. Donald Fenn Burnett. (to Rank Precision Industries Ltd.). British Patent 829,159. Feb. 24, 1960.

A portable radiation chamber is described which has an electrometer in a small chamber connected to an ionization chamber. The effective volume is that of the ionization chamber which is contained in a cylindrical tube which has the electrometer chamber and charging device at one end and a reading arrangement at the other. (T.R.H.)

**10661**

IMPROVEMENTS IN OR RELATING TO NEUTRON GENERATORS. (to Philips Electrical Industries Ltd.). British Patent 829,335. Mar. 2, 1960.

A neutron source is described which requires only one high-voltage supply lead making it suitable for use in bore-hole testing. The high-voltage lead is connected to a Cu block which has a Ag—Ti target layer. The anode is an Al cylinder which has an axial magnetic field supplied by a permanent magnet. The vacuum space is filled with $D_2$ which ionizes in the anode—cathode space in a 2000-v discharge. The D ions are accelerated to 100 or 200 kev against T adsorbed in the target to produce neutrons. (T.R.H.)

**10662**

A VACUUM FURNACE FOR VAPOURISING THE VOLATILE CONSTITUENT OF AN ALLOY. (to Commissariat à l'Énergie Atomique). British Patent 829,336. Mar. 2, 1960.

A vacuum furnace design is given for removing Zn from brasses at 650°C and $10^{-4}$ mm Hg to produce porous membranes. Heating elements are arranged in refractory materials around a hollow shaft which has a plate attached. The brass, in the form of a cylinder is placed on the plate and held by silica supports. Plate, shaft, and brass cylinder rotate inside the refractory cylinder so that heating is even and so that vaporized Zn has a chance to move to the cooled, finned, central shaft and condense. The whole is enclosed in an evacuated chamber. (T.R.H.)

**10663**

RADIOACTIVE DUST MONITORING DEVICE. Roderick Taylor, Alan Scott, and Edward Bowes (to Head, Wrightson & Co., Ltd.). British Patent 829,743. Mar. 9, 1960.

A gas coolant monitor for radioactivity is described. A rotary device has an exposure chamber through which a sample of the coolant stream can be diverted. Filters are rotated through the chamber and through a radiation detection instrument. Provision is made for replacement, removal, and storage of the filter disks. Periodically a new filter is charged to the exposure chamber simultaneously with discharge of an exposed filter to the detector and to the storage chamber. (T.R.H.)

## Materials Testing

**10664** NP-8423

Syracuse Univ., N. Y. Research Inst.

IN-AND-OUT-OF-PILE FATIGUE TESTING APPARATUS. Final Report. Eugene E. Drucker. May 1957. Appendix A: AN ELECTROMAGNETIC THRUSTOR. L. A. Mullin. Appendix B: EVALUATION OF PROPOSED PNEUMATIC FATIGUE TESTING MACHINE. E[ugene] E. Drucker. Appendix C: CONTROL SYSTEM CIRCUITRY. G. M. Baule. 47p. For General Electric Co. Contract NObs-56405, Subcontract No. N-132. (ME-389-575F).

An apparatus for in- and-out-of-pile fatigue testing under controlled strain conditions was designed and tested out-of-pile. The equipment makes possible fatigue tests of materials under closely controlled conditions within a nuclear reactor and with a very high degree of reliability. The maximum amount of useful information is received from the equipment and recorded. The simultaneous testing of 2 or 3 specimens is possible in an experimental hole of the Brookhaven graphite pile, while an unlimited number of specimens can be tested out-of-pile. An assembly drawing of the basic apparatus is included. (auth)

**10665** TID-7571(p.128-32)

Saint Louis Testing Labs., Mo.

USE OF RADIOISOTOPES FOR RADIOGRAPHY OF WELDMENTS AND CASTINGS. C. D. Trowbridge. 5p.

Applications of radioisotopes for radiography of weldments and castings are described. Results using gamma and x rays as sources are compared. (C.H.)

**10666** TID-7571(p.193-201)

Kansas State Coll., Manhattan.

DIFFUSION OF SODIUM AS A QUALITY TEST FOR CONCRETE. R. H. McFarland, C. H. Scholer, Shih Chi Chang and V. A. Swanson. 9p.

The ability of concrete to tolerate the presence of alkaline metal elements was investigated. Specimens of concrete were exposed to solutions of sodium-22, and measurements of the resulting diffusion were made. Results indicate a rapid initial movement of sodium into the water of the concrete with a subsequent much slower movement. Diffusion constants of the order of $10^{-8}$ cm$^2$/sec and $10^{-10}$ cm$^2$/sec may be associated with the two different phenomena. (C.H.)

**10667** TID-7571(p.229-46)

Picker X-Ray Corp., White Plains, N. Y.

THE ROLE OF ISOTOPES IN INDUSTRIAL RADIOGRAPHY. J. A. Reynolds. 18p.

Rapid advancements in the use of radioisotopes as radiation sources for industrial radiography are described. Typical problems and techniques in non-destructive testing are discussed. It is pointed out that components for nuclear power plants, missiles, and satellites have created new markets for radiographic isotopes in industrial radiographic equipment capable of penetrating dense materials and great thicknesses. (C.H.)

**10668**
ELECTRODE POTENTIAL TESTING. J. H. Bender, Jr., J. W. Dutli, and P. D. Edwards (Los Alamos Scientific Lab., N. Mex.). Nondestructive Testing 18, 99-102(1960) Mar.-Apr.

A description is presented of the development and some applications of a nondestructive test for ionic surface inclusions in metals, and for pores through an electroplate or cladding. The principle upon which this test method is based involves the electrode potential difference that exists between dissimilar ionic materials when immersed in a suitable electrolyte. The so-called "local action" that takes place in the vicinity of an inclusion or pore produces an electric field with considerable spatial distribution which may be rather easily detected. (auth)

**10669**
AUTOMATIC DATA PROCESSING IN NONDESTRUCTIVE TESTING. G. M. Taylor (Los Alamos Scientific Lab., N. Mex.). Nondestructive Testing 18, 127-30(1960) Mar.-Apr.

The development of an automatic data processing system for use in nondestructive testing is presented. The reasoning used in developing the system, the design, and the advantages and disadvantages of the chosen mode of operation of the system are discussed. Included in the discussion is the general nature of analog and digital representation of data. (B.O.G.)

**10670**
IMPROVEMENTS IN OR RELATING TO METHOD OF TESTING APPLICABLE TO THE CONTROL OF MANUFACTURE OF NUCLEAR REACTOR FUEL ELEMENTS. Hans Kronberger, Isaac Alan Mossop, and Francis Graham Brightman. (to United Kingdom Atomic Energy Authority). British Patent 829,353. Mar. 2, 1960.

A method of testing fuel elements for surface U contamination below 1 $\mu$g/foot is described. The fuel element is placed in an Al sleeve and surrounded by two semicylindrical ZnS phosphors. The phosphors are optically coupled to a photomultiplier-amplifier-counter arrangement. The fuel element, phosphors, and photomultipliers are placed in a neutron flux of $\sim 10^8$ neutrons/cm$^2$/sec and the fuel element is lowered past the phosphors at 4 in./min. Contamination is revealed by scintillation detection of fission fragments. (T.R.H.)

## GEOLOGY, MINERALOGY, AND METEOROLOGY

**10671** AERE-R-3196
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE OPERATION OF BOREHOLE LOGGING EQUIPMENT IN BOREHOLES CONTAINING SALINE SOLUTIONS. D. Williams and H. A. G. Cole. Jan. 1960. 17p. BIS.

It is shown that electrochemical potentials can be developed between the armor of logging cables and borehole casings when the hole contains a saline fluid. Spurious indications on the instrument are attributed to noise pulses generated when this galvanic cell is short circuited by probe movement; the effect is investigated in some detail. Simple modifications to the Type 1417A instrument circuit are described which permit discrimination against galvanic noise. The modified equipment was satisfactory on a field test. (auth)

**10672** RM-2456(AEC)
RAND Corp., Santa Monica, Calif.
PROBING THE EARTH WITH NUCLEAR EXPLOSIONS. D. T. Griggs and F. Press. Sept. 28, 1959. 41p. Contract AT(11-1)-135, Project Agreement No. 5. OTS.

Progress in seismology is reviewed with emphasis on the usefulness of past nuclear weapon tests in determining the internal structure of the earth. The advantages of using large chemical explosions and future nuclear explosions detonated under the PLOWSHARE program as controlled energy sources for carefully instrumented seismological experiments are discussed. Finally, an international program of explosions for seismological research is proposed, and specific suggestions are made for attacking several outstanding problems in seismology by means of chemical and clean nuclear explosions and the instrumentation network proposed at Geneva for nuclear test detection. (auth)

**10673** SCTM-160-55(51)
Sandia Corp., Albuquerque, N. Mex.
THE VARIABILITY OF ATMOSPHERIC PRESSURE. [PART] II. B. N. Charles. May 19, 1955. 22p. OTS.

Seasonal mean daily D-values and their standard deviations are estimated at the 700-mb level (about 10,000 ft above mean sea level) over the northern hemisphere, and presented in maps and tables. Linear interpolation between these data and similar data for sea level, as presented in Technical Memorandum 243-54-51, is then used to estimate seasonal D-values and their standard deviations at the 5000-ft level. (auth)

**10674** TEI-612
Geological Survey, Washington, D. C.
COMPARISON OF THICKNESS, GRADE, AND DEPTH OF RADIOACTIVE LAYERS AS DETERMINED BY GAMMA-RAY LOGGING AND BY CORE SAMPLING. Carl M. Bunker. Aug. 1959. 33p. OTS.

Thickness, grade, and depth data were obtained by analyzing gamma-ray logs and core samples from 56 diamond drill holes penetrating uranium deposits in the Colorado Plateau. The data from the two methods were compared to determine variations found in gamma-ray log interpretation and chemical and radiometric analyses of the drill core. Correlations within each parameter varied among the drilling areas analyzed. Gamma-ray interpretations of grade compared to chemical analyses were within the range of −10 to +25 per cent. Most depth measurements determined by gamma-ray log interpretation compared to drill core measurement were within 0.5 per cent. Results of the study indicate a need for better thickness definition in both gamma-ray logging and core scanning equipment. (auth)

**10675** TID-7571(p.8-13)
Halliburton Oil Well Cementing Co., Duncan, Okla.
SOME USES OF RADIOISOTOPES IN OIL FIELD OPERATIONS. R. George Mihram. 6p.

A number of radioisotopes are being used in the oil field. Primarily these radioisotopes are used to locate materials being placed in a well, or to locate a definite spot in the well. Isotopes have been used to locate the position and to identify the type of fracture produced when a well is fractured. Still other isotopes have been used with cementing operations to locate the cement behind pipe; to determine where squeezed cement has gone; or to locate cement channels. Several isotopes have been used in several different applications or methods to locate holes in the pipe; to determine a permeability profile of a formation. Many other applications are possible and have been used to some extent. (auth)

**10676** TID-7571(p.146-9)
Well Surveys, Inc., Tulsa, Okla.
RADIOACTIVITY OIL WELL LOGGING AND OIL FIELD TRACER APPLICATIONS. Alfred E. Caswell, Jr. 4p.

In the past twenty years radioactivity oil well logging has developed into an important asset to the petroleum industry. It supplies invaluable information to the petroleum engineers and geologists of the location of possible oil bearing formations and is a great aid in the exploitation of petroleum reservoirs. A brief history of radioactivity oil well logging along with short discussions of methods of logging such as gamma, neutron-gamma, neutron-neutron, tracer, and density logging is given. (auth)

**10677** TID-7571(p.162-7)
Radiochemistry, Inc., Louisville, Ky.
RADIOCHEMICAL ANALYSIS OF TRITIATED METHANE AND KRYPTON-85 IN NATURAL GAS. James E. Lewis. 6p.

A method for the analysis of tritiated methane and krypton-85 in natural gas at levels of one micromicrocurie per liter of gas and higher is discussed. The analysis is based on oxidizing the gas, vacuum separation of the components and counting the individual isotopes. It has wide application in the use of radioisotopes for investigating large underground gas systems and in secondary-oil recovery operations which use gas pressurization. (auth)

**10678** WT-343
Geological Survey, Portland, Ore.
GEOLOGIC, HYDROLOGIC, AND THERMAL FEATURES OF THE SITES. Arthur M. Piper. May 1952. Decl. Oct. 22, 1959. 71p., 2 illus. Project 1(8)a [of] OPERATIONS WINDSTORM AND JANGLE. OTS.

A survey was made of two sites for possible use as underground and surface weapons test sites. An area in Yucca Valley at the Nevada Test Site and an area on Anchitka Island, of the Aleutian chain, were examined for topographic, geologic, and hydrologic requirements. The Yucca valley site was selected as the site for Operation Jangle. Operation Windstorm was suspended. (C.H.)

**10679**
X-RAY POWDER DATA OF SYNTHETIC IRIGINITE. Neysa S. Rocha and Augusto Baptista (Departamento Nacional da Produção Mineral, Rio de Janeiro and Comissão Nacional de Energia Nuclear, Rio de Janeiro). Anais acad. brasil. cienc. 31, 413-15(1960). (In English)

Uranyl molybdate was synthesized by two different ways. Its x-ray powder pattern is very close to that of natural iriginite. (auth)

**10680**
THE SEPARATION OF TOTAL RARE EARTHS AND THORIUM FROM SOME MULTIPLE-OXIDE MINERALS. J. R. Butler and Rosemary A. Hall (Imperial Coll. of Science and Tech., London). Analyst 85, 149-50(1960) Feb.

The separation of total rare earths and thorium from some multiple-oxide minerals was performed by using the sulfur dichloride—chlorine method of decomposition. The residue was dissolved in nitric acid and treated with hydrofluoric acid to precipitate fluorides of the rare earths and thorium. Subsequent solution in perchloric acid and precipitation with methyl oxalate separated the rare earths from their fluorides. (C.J.G.)

**10681**
PRIMARY MINERALIZATION OF URANIUM-BEARING "SILICEOUS REEF" VEINS IN THE BOULDER BATHOLITH, MONTANA. PART II. THE VEINS. Barrie H. Bieler and Harold D. Wright (Pennsylvania State Univ., University Park). Econ. Geol. 55, 363-82(1960) Mar.-Apr.

The "siliceous reef" uraniferous veins of the Boulder batholith contain, in decreasing order of abundance, finely crystallized pyrite, sphalerite, galena, uraninite, tetrahedrite, argentite, chalcopyrite, and covellite. Microcrystalline quartz comprises over 90 percent of the vein material; opal and barite are minor. The color of the veins varies from light gray to black due to variation in size and concentration of the microscopic grains of opaque minerals. Microcrystalline quartz was deposited in several stages, separated by intervals of brecciation. Quartz of the later stages is generally dark gray to black. It occurs as fracture fillings in massive early microcrystalline quartz of light color, and as a cementing matrix about breccia fragments of the lighter quartz. The uranium content of nearly one hundred vein samples was determined by alpha counting and fluorimetry. Radioactive equilibrium of the uranium series is indicated by agreement between measured radium content (analyzed by New Brunswick Laboratory, AEC) and that required for equilibrium with uranium determined in two samples, and by general agreement between fluorimetric and alpha-activity determinations of uranium. Semiquantitative spectrographic analysis of the same samples provided data on the content and distribution of 28 minor elements in the veins. In most cases, the darker the vein quartz, the higher is the content of those elements generally occurring in opaque vein minerals: Ag, As, Ba, Co, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Sn, U, and Zn. Elements that showed no significant correlation with vein color are Al, B, Be, Ca, Cr, Cs, Ga, Ge, Mg, Na, P, Sr, Ti, V, and Zr. Five elements—Fe, As, Co, Mo, and Pb—showed a marked positive correlation with uranium. (auth)

**10682**
REJUVENATION OF PITCHBLENDE IN HERCYNIAN ORE DEPOSITS. C. F. Davidson (Univ. of St. Andrews, Scotland). Econ. Geol. 55, 383-6(1960) Mar.-Apr.

In a majority of instances, geochronological studies on pitchblende samples from the Hercynian granites of Western Europe reveal an age much younger than that of the granite plutons. This youthfulness is attributed to rejuvenation of an initial mineralization emplaced in Hercynian times. Before the geological history of such deposits can be correctly interpreted from mineragraphic investigations, the possibility of several periods of reworking must be recognized. (auth)

**10683**
A RELATIVE ABUNDANCE OF LITHIUM ISOTOPES IN URANIUM MINERALS AND METEORITES. K. G. Ordzhonikidze. Geokhimiya, No. 1, 37-44(1960). (In Russian)

The relatively frequent occurrence of lithium isotopes was investigated in uranium minerals and meteorites. The detected isotopic shifts of lithium in uranium minerals depended on the age of the mineral. In ancient uranium minerals the degree of enrichment in the heavy lithium isotope equaled 6.4 to 7.9% while in the youngest mineral it was 2.9%. The enrichment of uranium minerals in the heavy lithium isotope can be explained by the transformation of nuclei of the light boron isotope according to the nuclear reaction $B^{10} + n \rightarrow Li^{7} + \alpha$. The observed variations of the isotopic composition of lithium in meteorites were considerably weaker than in uranium minerals. (auth)

**10684**
International Atomic Energy Agency, Vienna.
SURVEYING AND EVALUATING RADIOACTIVE DEPOSITS. REVIEW SERIES NO. 1. DEVELOPMENTS IN THE

PEACEFUL APPLICATIONS OF NUCLEAR ENERGY. A. H. Lang. 1959. 56p.

Practical problems involved in the exploration and evaluation of radioactive deposits of uranium and thorium are discussed. Literature published in English in 1955 and later is reviewed. It is emphasized that general principles of prospecting and mining apply also to radioactive deposits. (C.H.)

## HEALTH AND SAFETY INCLUDING DOSIMETRY

**10685** AECU-4739
Chicago. Univ.
ATMOSPHERIC TRITIUM ANALYSIS. Technical Progress Report No. 2. Earl W. Barrett and Leonid Huebner. Feb. 16, 1960. 33p. Contract AT(11-1)-636. OTS.

A discussion of various technical improvements in the tritium analysis facility is presented. A summary is also given of the tritium content of Chicago precipitation from 18 December 1957 to 15 June 1959. A smooth decay curve was obtained during an undisturbed period of two months following the "Hardtack" weapons tests in the spring and summer of 1958; a residence time for water in the troposphere of 21.0 ± 1.4 days is reduced therefrom. Examination of the data following cessation of weapons tests reveals a major peak of tritium activity in March 1959; an anomalous peak in June 1959 is noted and discussed as a subject for further study. (auth)

**10686** AERE-M-589
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE IDENTIFICATION OF ALPHA ACTIVITY DETECTED ON LABORATORY AIR MONITORS AND COMPARISON OF SUITABILITY OF DIFFERENT TYPES OF FILTERS. K. M. Glover. Dec. 1959. 7p. BIS.

**10687** AFCRC-TN-59-627
Air Force Cambridge Research Center. Geophysics Research Directorate, Mass.
NATURAL AEROSOLS AND NUCLEAR DEBRIS STUDIES. Progress Report II. GRD Research Notes No. 24. M. I. Kalkstein, P. J. Drevinsky, E. A. Martell, C. W. Chagnon, J. E. Manson, and C. E. Junge. Oct. 19, 1959. 42p. Project 7690. Contract AT(49-7)-1431. OTS.

Some additional results of research on radioactive and inactive aerosols in the troposphere and stratosphere are presented. Results of studies of stratospheric particulate aerosols and of the size distribution of fission products in the lower atmosphere are discussed. Techniques of particulate aerosol collection and analysis are described. Results for barium-140 and strontium-90 in individual precipitation samples are presented together with preliminary meteorological interpretation. Some results for gamma-ray activities in precipitation and soil samples are discussed. (auth)

**10688** HW-63703
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
DISPOSITION OF CONTAMINATED PROCESSING EQUIPMENT AT HANFORD ATOMIC PRODUCTS OPERATION, 1958—1959. P. S. Kingsley. Feb. 12, 1960. 43p. Contract W-31-109-Eng-52. OTS.

A review and summary of the disposition of contaminated major processing equipment at HAPO during 1958—1959 are presented. A listing of equipment buried, equipment stored to be buried or decontaminated, and equipment decontaminated and returned to service is included. (J.R.D.)

**10689** NAA-SR-Memo-4801
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
RAINOUT CONTAINMENT. G. L. Wegmann. Jan. 12, 1960. 26p. OTS.

An evaluation of the efficiency of a sprinkler system as an airborne fission product containment mechanism is presented. The primary inadequacies and objections to such a system are outlined and data on droplet efficiencies are included. (J.R.D.)

**10690** NP-8169
Naval Radiological Defense Lab., San Francisco.
LONG-LIVED COBALT ISOTOPES OBSERVED IN FALL-OUT. P. O. Strom, J. L. Mackin, D. MacDonald, and P. E. Zigman. Mar. 26, 1958. Decl. Sept. 29, 1959. 13p. OTS.

Analyses of three samples of fall-out revealed the presence of the induced radioisotopes $Co^{57}$, $Co^{58}$, and $Co^{60}$. The amounts of these radioisotopes present in the samples would not constitute an internal hazard compared to the amounts of $Sr^{90}$ present in the samples. However, the $Co^{57}$, $Co^{58}$, and $Co^{60}$ values obtained indicate that these isotopes would contribute appreciably to the external gamma radiation from fall-out fields represented by the samples. The product/fission ratios of the individual nuclides were obtained. (auth)

**10691** TID-7571(p.21-6)
Division of Licensing and Regulation, AEC.
HEALTH, SAFETY, AND REGULATORY CONTROLS. G. W. Morgan. 6p.

The use of radioisotopes presents two general problems from the standpoint of radiation protection. These problems are protection from external exposure and protection from internal exposure or sources which have gained entrance into the body. Protection and control are afforded by adding special features to the laboratory or other area of use, the use of special facilities and equipment, the use of special techniques, and disposal of radioisotope wastes in a safe manner. The organization and administration of radiation safety programs are discussed. (C.H.)

**10692** TID-7571(p.156-61)
South Dakota. Dept. of Health, Pierre.
RADIATION PROTECTION SERVICES IN SOUTH DAKOTA. D. G. Kurvink. 6p.

The South Dakota State Department of Health Radiation Protection Program is reviewed. Included in the discussion are the provisions of the Radiation Protection Act and the Radiation Control Regulations of the South Dakota State Department of Health, a summary of radiation control activities of this agency, and some of the problems associated with the administration of the program. Special emphasis is given to the control of portable radiation sources and the handling of radiation accidents. (auth)

**10693** TID-7571(p.168-71)
Kansas. Board of Health, Topeka.
KANSAS BOARD OF HEALTH ACTIVITIES IN RADIATION PROTECTION. J. L. Mayes. 4p.

Present Kansas laws under which radiation protection activities are carried out, Kansas State Board of Health regulations pertaining to radiation, agency organization relative to radiation protection activities, current activities in radiation protection, and proposed legislation for atomic energy development and radiation protection are briefly described. (auth)

**10694** TID-7585(p.50-65)
Quartermaster Research and Engineering Command, Natick, Mass.
HIGH LEVEL DOSIMETRY SYSTEMS FOR FOOD PROCESSING BY IONIZING RADIATIONS. Reuben Pomerantz. 16p.

Types of dosimetry systems are reviewed. Emphasis is placed on systems suitable for use as dosimeters with food irradiation facilities. The advantages and disadvantages of the various systems are discussed. (C.H.)

**10695** TID-7585(p.131-4)
Massachusetts Inst. of Tech., Cambridge.
RADIOLOGICAL SAFETY. Albert O. Seeler. 4p.

Radiological safety procedures are reviewed. (C.H.)

**10696** USNRDL-TR-390
Naval Radiological Defense Lab., San Francisco.
DOSE-TIME-DISTANCE CURVES FOR CLOSE-IN FALL-OUT FOR LOW YIELD LAND-SURFACE NUCLEAR DETONATIONS. G. Henry and A. D. Anderson. Dec. 30, 1959. 13p.

Radiation dose computations made with the NRDL dynamic fall-out model for low-yield land-surface bursts have been used to show graphically the time after burst required for exposed personnel to accumulate certain doses from deposited fall-out as a function of downwind distance from ground zero. The curves indicate that significant doses may be accumulated rapidly within several miles downwind depending upon the yield and wind conditions. Since the effects of airborne radioactivity (transit dose) were not considered in this study, the curves indicate total accumulated doses (deposited only) which are less than the total doses which would be expected otherwise. (auth)

**10697** AEC-tr-4016
SEASONAL VARIATION OF STRATOSPHERIC FALLOUT COMPONENTS. G. Schumann and G. Eulitz. Translated by Gretchen Riese (Los Alamos Scientific Lab.) from Naturwissenschaften 47, 13-14(1960). 7p. JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, as abstract No. 7272.

**10698** JPRS-L-900-D
INFLUENCE OF ATOMIC EXPLOSIONS ON THE ATMOSPHERE. L. R. Rakipova. Translated from Meteorol. i. Gidrol., No. 6, 53-7(1957). 11p. OTS.

The catastrophic phenomena of weather as a result of the effects of artificial nuclear explosions in the atmosphere are very small. A more natural cause of sharply expressed anomality of atmospheric processes in recent years is the increase of solar activity in connection with the approach to the maximum of the century and 11-year cycles. With the aid of synoptic-statistical investigations as well as theoretically, it was shown that in addition to this, the cyclonic activity of the atmosphere, i.e., large-scale mixing of air masses, was increased. As a consequence of this, zonal circulation is destroyed, and meridional circulation is intensified in the general circulation. Intensive air exchange between high and low latitudes may lead to the creation of large temperature anomalies (positive in high and negative in low latitudes) which were observed especially in 1954, as well as in the winter of 1956/1957. (auth)

**10699**
METABOLIC CHARACTERISTICS WITHIN A CHEMICAL FAMILY. Patricia W. Durbin (Univ. of California, Berkeley). Health Phys. 2, 225-38(1960) Feb.

The available data have been reviewed for the biological behavior in rats of high specific-activity radioisotopes of seventy elements. Tracer quantities were administered in single intramuscular injections. Groups of rats were autopsied at various intervals, and tissues and excreta were assayed for radioactivity. Distribution data were arranged according to the grouping of the periodic table of the elements. The anions (including the halogens), the oxygenated or halogenated ions of Groups IV, V, and VI, and the transition metals were rapidly eliminated by the kidney. The monovalent alkali metals were distributed almost uniformly in soft tissue with subsequent excretion by the kidney. The bivalent cations, except Hg$^{2+}$, Cd$^{2+}$, and UO$_2^{2+}$, were deposited primarily in bone mineral and were eliminated slowly in both urine and feces. The tripositive elements of Group III, the lanthanides, and the actinides were deposited in liver and bone. The liver fraction was excreted via the bile without recirculation, while that deposited in bone was turned over at a rate slower than that of normal bone remodelling. The quadrivalent cations such as Zr$^{4+}$, Th$^{4+}$, and PuO$_2^{2+}$ were deposited almost exclusively in bone and were bound more strongly than the Group III elements. The properties that determine biological behavior include the oxidation state stable at body pH; the solubility of the stable state; the tendency to be incorporated into organic compounds; and the tendency to associate with specific proteins. 67 references. (auth)

**10700**
THE NORMAL RADIUM CONTENT AND THE Ra$^{226}$/Ca RATIO OF VARIOUS FOODS, DRINKING WATER AND DIFFERENT ORGANS AND TISSUES OF THE HUMAN BODY. H. Muth, B. Rajewsky, H.-J. Hantke, and K. Aurand (Max Planck-Institut für Biophysik, Frankfurt am Main). Health Phys. 2, 239-45(1960) Feb.

New experimental results concerning the normal radium (Ra$^{226}$) content of food, drinking water, the distribution of normal radium in the human body, and the Ra$^{226}$/Ca ratio are reported. The daily uptake of radium by a standard man amounts to about 3 × 10$^{-12}$ c, and under normal environmental conditions, 90 per cent of this amount enters the body with food and only 10 per cent with water. The natural radium is not concentrated exclusively in bone. Considerable amounts are distributed throughout the soft tissue and the different organs. Animal experiments demonstrated that there exists no dependence on age of the normal radium content. The consequences of these results for the estimation of the distribution pattern of other bone-seekers are discussed. (auth)

**10701**
THE PREPARATION OF THIN, UNIFORM, RADIOACTIVE SOURCES BY SURFACE ADSORPTION AND ELECTRODEPOSITION. R. L. Blanchard, B. Kahn, and R. D. Birkhoff (Oak Ridge National Lab., Tenn.). Health Phys. 2, 246-55(1960) Feb.

Thin, uniform, radioactive sources were deposited by several methods on thin films composed of a sandwich of metal, polystyrene, and formvar. Sources of cerium-144, yttrium-91, scandium-46, and ruthenium-106 were prepared by adsorbing the hydrolyzed radionuclides on gold-coated films, while selenium-75, ruthenium-106, iridium-192, cobalt-60, and chromium-51 were adsorbed in the elemental form on magnesium. Ruthenium-106, silver-110, mercury-203, cobalt-60, indium-114, iron-59, chromium-51, and gold-198 were electrodeposited on gold, the plating potential being supplied either externally or by a dissolving magnesium cathode. The uniformity of the sources was evaluated by radioautography, and in the case of Au$^{199}$ by examining the conversion electron spectrum with a homogeneous-field solenoidal-type beta spectrometer. (auth)

**10702**

HEALTH PHYSICS FIELD OPERATIONS IN ATOMIC ENERGY COMMISSION WEAPONS TESTING PROGRAM. R. H. Goeke and C. L. Weaver (U. S. Atomic Energy Commission, Albuquerque, N. Mex.). Health Phys. 2, 256-60(1960) Feb.

Health physics in the support of field operations at the Nevada Test Site and Eniwetok Proving Ground is briefly discussed. At the test sites, the terms radiological safety and health physics are used interchangeably. Radiological safety requirements necessary to control radiation exposure of all participating personnel at both sites are presented. The organizational setup for health physics support services and assignment of responsibilities for control of radiation exposure to personnel are discussed. The necessary supporting rad-safety functions such as training of monitors, use of aircraft and instrumentation, are included. (auth)

**10703**

IN VIVO GAMMA COUNTING AS A MEASUREMENT OF URANIUM IN THE HUMAN LUNG. R. E. Cofield (Union Carbide Nuclear Co., Y-12 Plant, Oak Ridge, Tenn.). Health Phys. 2, 269-87(1960) Feb.

A direct, in vivo method is reported for the measurement of uranium within the human lung, utilizing the detection by scintillation spectroscopy of the gamma radiation accompanying alpha decay of the uranium. The in vivo gamma counting facility includes a low background counting chamber with 8-in. thick iron walls, NaI scintillation detector, and a multichannel pulse-height analyzer. To achieve a quantitative estimate of uranium concentration, two techniques for estimating the normal, non-uranium gamma activity at the characteristic uranium gamma energies have been developed. Calibrations have been derived from measurements of samples in phantoms simulating the human chest. The 186 kev gamma line from $U^{235}$ is the most suitable for measurement, but if secular equilibrium is assumed, the 90 kev lines of the uranium daughters may be used. The ratio of the 90 kev line to the 186 kev line may be used as an indication of $U^{235}$ abundance. Quantities as low as 50 per cent of the maximum permissible body burden of any of the isotopic enrichments investigated can be measured. (auth)

**10704**

URINALYSIS METHOD FOR ENRICHED URANIUM. A. L. Boni (E. I. du Pont de Nemours and Co., Aiken, S. C.). Health Phys. 2, 288-90(1960) Feb.

A urinalysis procedure was developed for the estimation of micro-amounts of enriched uranium which are coprecipitated with an ammoniacal alkaline earth phosphate precipitate. The precipitate is fired in a muffle furnace and the enriched uranium purified by anion exchange. The isolated enriched uranium is electroplated and determined by autoradiography. The method has a sensitivity of 0.015 ± 0.007 d/m per 150 ml of sample, a recovery of 94 per cent, and a standard deviation of ±16 per cent. (auth)

**10705**

ELECTRODEPOSITION OF URANIUM FROM URINE. George W. Royster, Jr. (Oak Ridge National Lab., Tenn.). Health Phys. 2, 291-4(1960) Feb.

Electrodeposition of uranium from wet ashed urine solutions shows a wide variation of recovery between different specimens. This lack of precision is generally attributed to a co-deposition of inorganic salts which reduces the detectable alpha activity by absorption. A series of samples was plated after adding to aqueous solutions of uranyl nitrate the major cations normally found in urine—calcium, magnesium, sodium, and potassium. The principal trouble-causing elements are calcium and magnesium, and their removal as the carbonate and the phosphate, respectively, was effective in eliminating the extraneous salt deposits on the plates. Recoveries from 33 different urines tested averaged 89.5 ± 4 per cent. (auth)

**10706**

POWER FUNCTIONS RELATING EXCRETION TO BODY BURDEN. S. Marshall Sanders, Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Health Phys. 2, 295-303(1960) Feb.

Formulas necessary to relate the quantity of radionuclides excreted to that assimilated in exposures that are acute and those that are multiple or continuous are derived from power-function relationships. Particular attention is given to providing equations having variables for which the bio-assayer can easily derive numerical values. (auth)

**10707**

ON THE PRESENT POSSIBILITIES OF WASHING RADIOACTIVE SUBSTANCES OFF THE SKIN OF LIVING ANIMALS. J. Nosek and V. Chmelař (Charles' Univ., Prague). Health Phys. 2, 306-7(1960) Feb.

Experiments on animals showed that a detergent and sodium salts of EDTA acid or a detergent and sodium salts of polyphosphoric acids are effective for the decontamination of living skin contaminated with long-life fission products of uranium-235. The formulas are included for two decontaminating solutions which proved effective. (C.H.)

**10708**

RADIATION PROTECTION IN REACTORS AND IN NUCLEAR ENGINEERING OPERATIONS. M. Oberhofer and P. Kienle. (Technische Hochschule, Munich). Kerntechnik 2, 58-60(1960) Feb. (In German)

Photoemulsions as radiation detectors and the measurement methods based on them for the determination of radiation doses and fluxes are described. (tr-auth)

**10709**

THE PROTECTION OF WORKERS AGAINST IONISING RADIATIONS. Occupational Safety and Health 9, 177-81 (1959) Oct.-Dec.

In June 1959 a Committee was set up by the International Labor Conference to prepare international rules relating to the protection of workers against ionizing radiations. The Committee concluded in favor of a Convention supplemented by a Recommendation. A resolution was adopted concerning coverage by workmen's compensation of harmful effects of ionizing radiations. The text of the proposed conclusions and of the resolution is presented. (C.H.)

**10710**

A COMPREHENSIVE RADIATION CONTROL PROGRAM IN NEW YORK CITY. Hanson Blatz (New York Univ.—Bellevue Medical Center). Radiology 74, 474-9(1960) Mar.

A Radiation Health Code became effective in New York City on June 15, 1958. The Code provides for the registration of all radiation sources within New York City and requires compliance with recommendations of the National Committee on Radiation Protection. The program of radiation control is reviewed. (C.H.)

**10711**

DOSE AND DOSE MEASUREMENTS IN IONIZING RADIA-

TIONS. R. Glocker (Technische Hochschule, Stuttgart). Z. Physik 158, 145-50(1960). (In German)

The concept of radiation dose, originating on a medical basis, is finding acceptance, in increasing proportions, in physical colloquial usage. Therefore, the necessity arises of obtaining the exactness necessary for physical magnitudes by a mathematical form of the dose definition. The variation between the differential and mean dose is described. Proof that in the differential dose a general assignable relationship between the dose in the measuring body and that in the object exists only in two cases (electron equilibrium or Bragg-Gray principle). (tr-auth)

## ISOTOPE SEPARTION

**10712** CISE-34

Centro Informazioni Studi Esperienze, Milan.

CONSIDERAZIONI TEORICHE SULLA SEPARAZIONE DI ISOTOPI PER DIFFUSIONE GASSOSA ATTRAVERSO UNA PARETE POROSA. (Theoretical Consideration of Isotope Separation by Gaseous Diffusion through a Porous Barrier). P. Caldirola. 1953. 34p.

A theoretical treatment of the gaseous diffusion process is given. The problem is stated, and equations for the dynamics of viscous fluids are given. Consideration is then given to limited layers, porous barriers and diffusion layers, elementary theory of isotope separation by diffusion, the coefficient of separation and enrichment, and application to $UF_6$. (T.R.H.)

**10713** CISE-41

Centro Informazioni Studi Esperienze, Milan.

CONSIDERAZIONI TEORICHE SULLA SEPARAZIONE DEGLI ISOTOPI MEDIANTE DIFFUSIONE GASSOSA. EFFETTI DELLA STRUTTURA DELLA PARETE. (Theoretical Consideration of the Separation of Isotopes by Gaseous Diffusion. Effects of Barrier Structure). P. Caldirola and L. Selmi. 1954. 34p.

A theoretical treatment of isotope separation by gaseous diffusion is given. The theory of transport of gaseous mixtures is considered and applied to $UF_6$. (T.R.H.)

**10714** HW-59329

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

SEPARATION OF MERCURY ISOTOPES BY SELECTIVE PHOTOEXCITATION. E. E. Voiland. Mar. 5, 1959. 16p. Contract W-31-109-Eng-52. OTS.

A summary of existing experimental findings related to the separation of mercury isotopes by the photosensitization method is presented. Reported single stage enrichments from the natural abundance of 29.6 to 83 per cent give encouragement that this method may be economically feasible for the recovery of either mercury-202 or mercury-204. Possible methods for separating mercury-204 are proposed and discussed along with some of the factors which affect the process feasibility. It is concluded on the basis of existing data, that it is technically possible to produce high purity mercury-204 by this method, but that further data related to the extent of conversion, the degree of attainable purity and the process flow requirements, are necessary and must be developed before a meaningful economic evaluation can be made. (auth)

**10715** NP-tr-400

OPTIMUM CONDITIONS FOR THE ENRICHMENT OF HEAVY WATER IN HOT-COLD COLUMNS. PART II. THE ENRICHING SYSTEM, THE STRIPPING SYSTEM AND THE TRANSFER COLUMN. K. Bier. Translated by F. Hudswell (U.K.A.E.A. Atomic Energy Research Establishment) from Chem.-Ing.-Tech. 31, 22-30(1959). 30p. JCL.

The optimum conditions for separating heavy water in hot-cold columns are discussed. The problems connected with increasing the deuterium yield by means of hot-cold pairs of columns working as a stripping system with the inclusion of transfer columns are also examined. (J.R.D.)

**10716**

PILOT PLANT DATA FOR HYDROGEN ISOTOPE DISTILLATION. T. M. Flynn (National Bureau of Standards, Boulder, Colo.). Chem. Eng. Progr. 56, No. 3, 37-42(1960) Mar.

The principles of the chemical and dual temperature exchange processes for heavy water production are discussed. The operation and performance of a pilot plant distillation column to separate the system $H_2-HD$ are described. The pilot plant is capable of increasing the concentration of HD in $H_2$ from 0.03 to 3% with a capacity equivalent to the production of 48 pounds of heavy water in an 8000 hour year. Over-all plate efficiencies for vapor velocities of 0.2 to 2.0 in./sec were found to vary from 45 to 55%. Heat transfer and insulation problems are discussed. (C.J.G.)

**10717**

THE APPLICATION OF MIXED SOLVENTS IN THE SEPARATION OF CARBON ISOTOPES BY THE BICARBONATE METHOD AND THE USE OF ISOTOPIC EXCHANGE BETWEEN $CO_2$ AND $CO_3$ FOR THE SEPARATION OF OXYGEN ISOTOPES. I. A. Semiokhin, G. M. Panchenkov, and I. A. Zhurov. Zhur. Fiz. Khim. 33, 2633-5(1959) Nov. (In Russian)

Mixed solvents were used in seeking effective isotopic separation. In experiments with $CO_2$, 5% methyl alcohol and 5% acetone in volume to 20% potassium bicarbonate solution and a synthetic aluminum silicate catalyzer in a 3.5 × 5 cm column containing 16.0% $Al_2O_3$ were used. The rate of potassium bicarbonate supply into the column was 4.0 ± 0.1 ml/min. The results show that 5% methyl alcohol does not affect separation of carbon isotopes while 5% acetone improves the general partition factor from 1.044 to 1.100 following 24 hours of operation. Isotopic exchange in a $CO_2-HCO_3-CO_3$ system is suggested for concentrating $O^{18}$. (R.V.J.)

## MATHEMATICS AND COMPUTERS

**10718** ANL-6095

Argonne National Lab., Lemont, Ill.

A GENERAL PROGRAM FOR CALCULATING CROSS-SECTIONS IN WAVE MECHANICS. Kenneth Smith. Jan. 1960. 16p. Contract W-31-109-eng-38. OTS.

The wave mechanical cross-section formulas for one incident channel and N exit channels are derived in matrix form. A method for calculating these cross sections is discussed and a listing of the Fortran program used on an IBM-704 is given. As an illustration, the program is used to calculate cross sections obtained in the weak coupling approximation in the scattering of positrons by atomic hydrogen. (auth)

**10719** K-1440

Oak Ridge Gaseous Diffusion Plant, Tenn.

NLLS: A 704 PROGRAM FOR FITTING NON-LINEAR CURVES BY LEAST SQUARES. Parkhurst B. Wood. Jan. 28, 1960. 62p. Contract-W-7405-eng-26. OTS.

A program has been written, for an IBM Type 704 Computer, which performs the functions common to all problems of obtaining least squares estimates of the parameters in non-linear functions. Thus, to solve a particular problem of this type, the user needs only to furnish a program in which the function being fitted and its derivatives are evaluated. Also, several other programs—an overflow/underflow procedure and function subroutines often used in curve fitting problems—have been modified for use with the Non-Linear Least Squares program. (auth)

**10720** KAPL-2033
Knolls Atomic Power Lab., Schenectady, N. Y.
THE EFFECT OF SEQUENTIAL BATCHING FOR ACCEPTANCE-REJECTION SAMPLING UPON SAMPLE ASSURANCE OF TOTAL PRODUCT QUALITY. M. Halperin and G. L. Burrows. Dec. 1, 1959. 15p. Contract W-31-109-Eng-52. OTS.

What can be said about over-all grand lot quality is examined on the basis of random samples from batches or sublots disposed of sequentially as they are produced. Assurance always depends upon how the sample is selected and upon assumptions (restrictive or otherwise) about the population from which the sample came. The wisdom of assuming that a statistically controlled process is a single process is questioned. Moreover, certain properties of the sample are pointed out, stratified as it is over time of production, and of the population it represents, decimated as it may be by rejection of some sublots; because of these properties, certain assurance statements based on such samples should not be expected from a vendor. A valid method is demonstrated for making the quality assurance statements that are possible on the basis of such samples. (auth)

**10721** KAPL-2038
Knolls Atomic Power Lab., Schenectady, N. Y.
SYMMETRIC SUCCESSIVE OVERRELAXATION IN SOLVING DIFFUSION DIFFERENCE EQUATIONS. G. J. Habetler, E. L. Wachspress, and B. D. Baldwin. Apr. 14, 1959. 12p. Contract W-31-109-Eng-52. OTS.

Further analysis of the symmetric successive over-relaxation scheme for solving elliptic difference equations, described by Sheldon, indicates that this scheme is inferior to successive over-relaxation for solving reactor diffusion problems. (auth)

**10722** KAPL-2040
Knolls Atomic Power Lab., Schenectady, N. Y.
CONCERNING THE IMPLICIT ALTERNATING-DIRECTION METHOD. G. J. Habetler. Apr. 30, 1959. 17p. Contract W-31-109-Eng-52. OTS.

The convergence of the Sheldon-Wachspress generalization of the implicit alternating-direction method for constant $\rho$ is established. Other aspects of the method are analyzed, including optimum $\rho$, varying $\rho$, and a related implicit alternating-direction method. (auth)

**10723** KAPL-M-SXB-1
Knolls Atomic Power Lab., Schenectady, N. Y.
SOME NUMERICAL STUDIES OF SIMULTANEOUS TWO GROUP INVERSION. S. Baron. Feb. 2, 1960. 20p. Contract W-31-109-Eng-52. OTS.

A method to increase convergence in solving group diffusion equations simultaneously by transformation of the multigroup operator was tested. The tests described investigated the stability of the method, its convergence rate, and its ability to solve for the higher modes. (T.R.H.)

**10724** LA-2367
Los Alamos Scientific Lab., N. Mex.
THE SOLUTION OF THE GENERAL LEAST SQUARES PROBLEM WITH SPECIAL REFERENCE TO HIGH-SPEED COMPUTERS. R. H. Moore and R. K. Zeigler. Oct. 15, 1959. 94p. Contract W-7405-eng-36. OTS.

The general problem of least squares analysis is discussed. Special emphasis is placed on functions in which the parameters appear nonlinearly and which can be fitted by Gauss' well-known iterative method. The procedure is useful with any type of computing facility. A family of Fortran II subroutines which solves problems with this method is presented. Several examples of functions fitted by the method are shown. (auth)

**10725** NYO-2881
New York Univ., New York. Atomic Energy Commission Computing and Applied Mathematics Center.
TWO METHODS USING POWER SERIES FOR SOLVING ANALYTIC INITIAL VALUE PROBLEMS. Glenn Lewis. Jan. 1, 1960. 68p. Contract AT(30-1)-1480. OTS.

Given any analytic non-characteristic initial value problem it is possible to obtain a truncated power series as an approximation to the solution. The complete power series, from which the truncation comes, may not have a domain of convergence large enough to cover the area of interest. Two methods for continuing these truncated power series, similar to analytic continuation for a complete power series, are given. Proofs are also given that these two methods of continuation converge, as the number of terms in the truncated power series goes to infinity, to the same values as the analytic continuation of the complete power series. These two methods are applied to the problem of finding the supersonic flow past a blunt axisymmetric body and the results are compared. (auth)

**10726** SCR-143
Sandia Corp., Albuquerque, N. Mex.
TABLES OF THE BINOMIAL DISTRIBUTION FUNCTION FOR SMALL VALUES OF P. William H. Robertson. Jan. 1960. 208p. OTS.

Tables are presented for the cumulative binomial distribution for values of the parameter P from 0.001 to 0.050 in increments of 0.001 and for values of N from 2 to 1000 with varying increments. (auth)

# METALS, CERAMICS, AND MATERIALS

## General and Miscellaneous

**10727** BM-RI-5581
Bureau of Mines.
ELECTROREFINING BERYLLIUM. Preliminary Studies. M. M. Wong, F. R. Cattoir, and D. H. Baker, Jr. June 1959. 12p.

A brief investigation was made to determine the feasibility of electrorefining Be in a $KCl-LiCl-BeCl_2$ bath. Thin, platelike crystals of Be metal were produced by electrolyzing technical-grade Be metal beads (about 94% purity) as the soluble anode. Operating cell conditions were: Temperatures of 450 to 600°C.; an inert atmosphere; bath compositions of (1) 38.1 mole % KCl, 54.8 mole % LiCl, and 7.1 mole % $BeCl_2$ and (2) 36.7 mole % KCl, 52.7 mole % LiCl, and 10.6 mole % $BeCl_2$; cell voltages of 0.30 to 0.80; and initial cathode current densities of 50 to 435 amp/sq ft. Current efficiencies ranging from 87 to 96% were obtained. Qualitative spectrographic analyses of the metal products indicated that impurities were reduced. This technique offers the possibility of producing a grade of Be purer than that now generally available, which may have better mechanical properties. (auth)

**10728** BMI-867
Battelle Memorial Inst., Columbus, Ohio.
INVESTIGATION OF THE BEHAVIOR OF $NaOH-UO_3$ SLURRIES IN SMALL FLOW LOOPS. J. H. Stang, J. F. Lagedrost, E. M. Simons, and R. W. Dayton. Sept. 15, 1953. Decl. Feb. 24, 1960. 30p. Contract W-7405-eng-92. OTS.

The behavior of $NaOH-UO_3$ slurries (5 wt.% $UO_3$) circulating in a heat-exchange system was investigated. The problems emphasized included the stability of the slurry against settling and agglomeration upon thermal cycling. Dynamic tests in all-Ni loops indicated that, at 1000°F, such slurries could be circulated and thermally cycled successfully for long periods of time in a properly designed flow system. This is based primarily on favorable indications of stability at 1000°F, even though all slurries handled exhibited rapid settling characteristics in the static system of a special apparatus designed to measure settling rates. However, at 1400°F, continued circulation would not be possible because of a tendency of the slurry to deposit on walls in the cooler parts of the system. The deposition of Ni, which was also heavy when the peak temperature was 1400°F, may have encouraged this deposition. Another factor which probably contributed to the increased deposition at the higher temperature is that slurry particle sizes were found to increase with the maximum temperature to which the slurry was heated. (auth)

**10729** BMI-1398
Battelle Memorial Inst., Columbus, Ohio.
PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING NOVEMBER 1959. Russell W. Dayton and Clyde R. Tipton, Jr. Dec. 1, 1959. Decl. Feb. 10, 1960. 108p. Contract W-7405-eng-92. OTS.

A comparison of the creep properties of 15% cold-worked Zircaloy-2 and of annealed Zircaloy-2 is being made. In studies to develop a fuel element leak detector which removes fission products from reactor-coolant streams, experimental work included the determination of the exchangeability of $Br^{82}$ and AgBr, determination of gross fission-product retention by AgBr columns, and studies to determine possible methods of reducing gross fission-product contamination of AgBr columns. A thermal-neutron-flux monitoring system is being developed for the Hanford reactors. In the development of corrosion-resistant welding alloys for use with Hastelloy F, twelve experimental Ni-base alloys have been prepared. Aluminum–35 wt.% U alloys containing small additions of Sn or Zr are being evaluated on the basis of casting and fabricating characteristics, mechanical properties, and corrosion resistance in 200°C water. Data are reported on the effect of fast neutron reactions on the activation analysis of cement and cement raw materials. The investigation of radiation-induced free radicals and grafting of polyethacrylates was continued. The studies concerned with stabilizing $UO_2$ by additions of $La_2O_3$ or $Y_2O_3$ plus CaO were continued. An investigation is being conducted to determine the effects of high pressure and high temperature on the $U-O_2$ system and on reaction of uranium oxide with various mixed oxides. A surveillance program concerned with the effects of irradiation on mechanical properties of AISI Type 347 stainless steel is in progress. Because of difficulties encountered in cold rolling Nb-base binary alloys of 1.83 wt.% Cr and 4.33 wt.% Zr and several Nb-base ternary alloys, an attempt was made to warm roll the forged billets at 800°F. The evaluation of selected Nb-base alloys for service in pressurized-water reactors was continued. An investigation of the creep properties of Zircaloy-2 during irradiation at elevated temperatures was undertaken. Investigations are being made to establish the feasibility of continuously monitoring the oxygen content of large Na systems at concentrations below 10 ppm. Results of analysis for hydrogen content of Nb–U alloys after 140 days in 680°F water are presented. Corrosion data are presented for Nb–U alloys exposed in 600°F water and in NaK at 1600°F. Various studies are being directed toward understanding the causes of gas release in $UO_2$. Fabrication techniques are being developed for the preparation of cermet fuel materials containing 60 to 90 vol.% of $UO_2$ dispersed in Cr, Mo, Nb, and stainless steel matrices. The gas-pressure-bonding technique is being investigated as a possible method for fabricating Mo- and Nb-clad ceramic and cermet-type fuels. Fabrication methods are described for UC. The rate of self-diffusion of U in UC is being studied by using a tracer technique. The migration of hydrogen in Zr under the influence of a thermal gradient is being examined. Experiments were begun in producing $UO_2$ crystals from the vapor phase. In support of the Pebble-Bed Reactor program Battelle is studying the properties and fission-gas retention of fueled-graphite spheres. Data are reported on preirradiation and postirradiation measurements of UC specimens in capsules BMI-23-3 and BMI-23-5. Studies were begun on the preparation of large fuel plates containing $UO_2$ platelets. Studies are being conducted on the development of fuel, absorber, and suppressor materials for the SM-2. (For preceding period see BMI-1391.) (W.L.H.)

**10730** BMI-1418
Battelle Memorial Inst., Columbus, Ohio.
DEVELOPMENT OF HIGH-STRENGTH CORROSION-RESISTANT ZIRCONIUM ALLOYS. John A. De Mastry, Frederic R. Shober, and Ronald F. Dickerson. Feb. 22, 1960. 19p. Contract W-7405-eng-92. OTS.

Approximately 100 ternary and quaternary sponge-zirconium alloys were screened for structural and cladding applications in a natural-uranium-fueled heavy-water-moderated power reactor. The alloy additions studied included 2 to 4 wt.% Sn, 0.5 to 2 wt.% Mo, and 1 to 3 wt.% Nb. The effect of 0.1 wt.% Fe and 0.05 wt.% Ni additions to the experimental alloys was evaluated. All compositions were arc melted, rolled at 850°C from a helium-atmosphere furnace, vacuum annealed 4 hr at 700°C, and furnace cooled. Room- and elevated-temperature hardness measurements were used to estimate the tensile strengths of the alloys, while corrosion resistance was evaluated by 1000-hr exposures to static 300°C water. (auth)

**10731** CF-60-3-39
Oak Ridge National Lab., Tenn.
5-GPM IN-PILE THORIUM OXIDE SLURRY LOOP DEVELOPMENT, RUNS 14 THROUGH 16 IN LOOP L-4-24S, AND FILTRATION OF THORIUM OXIDE SLURRY WITH SINTERED FILTERS. J. M. Baker, D. T. Jones, and H. C. Savage. Mar. 7, 1960. 21p. OTS.

Out-of-pile circulation of thorium oxide slurries for 1400 hr at 250°C (runs 14, 15, and 16) in a 5-gpm in-pile pump loop indicates that the loop is capable of operation with slurries at concentrations to 1000 g of Th per kg of $H_2O$. The thorium oxides used were calcined at 1600°C and had mean particle sizes of 2 to 3 $\mu$. In this loop it is necessary to prevent entry and accumulation of slurry in the low-velocity horizontal pressurizer and pump-rotor cavity. This was accomplished by using the thoria-free filtrate from a sintered-metal filter located in the loop main-stream piping. Eight sintered-metal and one aluminum oxide sintered filter have been tested for use in the slurry loop. Present indications are that the maximum pore diameter of the filter material must be less than ~10 $\mu$ to provide a thoria-free filtrate for thorium oxides having mean particle sizes of 2 to 3 $\mu$. (auth)

**10732** KAPL-967
Knolls Atomic Power Lab., Schenectady, N. Y.
MECHANICAL RESONANCE TESTING OF FUEL SLUGS.
C. Mannal. July 30, 1953. Decl. Feb. 4, 1960. 75p. Contract W-31-109-Eng-52. OTS.

This report describes the application of a mechanical resonance method to the determination of defects in bonds between the Al can and the U in Hanford slugs. Longitudinal, transverse, and torsional excitations were employed. The fundamental natural resonant frequency and the resonant peak width in each of these modes could be determined with great rapidity and precision. Correlation of these observations with known defects in the slugs gave a selection principle by which defective slugs could be identified in many, but by no means all, cases. It is concluded that a production test based on this method would not be superior to those tests already in existence. Details of apparatus and techniques are given. (auth)

**10733** LAMS-2382
Los Alamos Scientific Lab., N. Mex.
A BIBLIOGRAPHY OF REPORT LITERATURE ON BERYLLIUM, JANUARY 1954—NOVEMBER 1959. Helen J. Chick, comp. Nov. 10, 1959. 65p. Contract W-7405-eng-36. OTS.

A bibliography containing 237 references to report literature published between January 1954 and November 1959 is presented on the properties, metallurgy, and fabrication of beryllium. (C.J.G.)

**10734** MHC-5
Metal Hydrides, Inc., Beverly, Mass.
SUPPLEMENTARY TECHNICAL REPORT ON AN IMPROVED PROCESS FOR THE MANUFACTURE OF HIGH PURITY CALCIUM. Period [covered]: November 10, 1948 to January 31, 1949. H. Brown and P. Woodberry. Dec. 26, 1948. Decl. Feb. 16, 1960. 42p. Contract AT-30-1-GEN-213, Supplemental Agreement No. 1. OTS.

Experimental work was carried out to improve material conversion efficiency to reduce handling costs inherent in the present process for production of high purity Ca. Charges up to 54 pounds were handled successfully in the equipment available. Material losses were reduced, and more complete removal of alkali and alkaline earth metals was effected by controlled pressures of inert gas by melting under positive pressure of Ar. (auth)

**10735** NAVORD-6484
Naval Gun Factory, Washington, D. C.
LITERATURE SURVEY ON COPPER BASE ALLOY CASTINGS FOR GAS AND HYDROSTATIC PRESSURE APPLICATIONS. Vincent DePierre and Shingo Inouye. May 15, 1959. 44p. (NGF-T-30-58).

A survey of the literature was made on copper base alloy pressure castings relative to: the defects responsible for leakage in pressure castings, the alloys generally used in bronze pressure castings, and the major factors influencing the pressure tightness of these alloys. A bibliography containing 85 references is presented. (auth)

**10736** NP-8386
Aktiebolaget Atomenergi, Stockholm.
CHOICE OF STEEL FOR THE R3/ADAM PRESSURE VESSEL. O. Källbäck. Sept. 23, 1959. 15p. (S-5).

For presentation at the EAES-Symposium on Reactor Materials, Saltsjöbaden, Stockholm, October 5—9, 1959.

A description of the R3/Adam reactor is given and the development of an acceptable carbon—manganese steel for use in the pressure vessel is discussed along with stainless steel for vessel cladding. Data on steel specifications are included. (J.R.D.)

**10737** NP-8427
Illinois Inst. of Tech., Chicago. Armour Research Foundation.
INVESTIGATION OF GRAPHITE BODIES. Progress Report No. 1 for the Period October 1 to December 31, 1958. S. W. Bradstreet. Jan. 1, 1959. 10p. Project No. G-039. Contract AF33(616)-6143.

The work reported includes initial investigation of furfuryl alcohol as a binder and briefly describes the apparatus being assembled for fabrication and measurement of multicrystalline graphite specimens in the future. (auth)

**10738** NP-8444
Syracuse Univ., N. Y. Research Inst.
COMPOSITE MATERIALS AND COMPOSITE STRUCTURES. Proceedings of the Sixth Sagamore Ordnance Materials Research Conference Conducted at Sagamore Conference Center, Racquette Lake, New York, August 18, 19, 20, and 21, 1959. 559p. Contract DA-30-069-ORD-2566. (MET-661-601).

Twenty-two papers were presented at the conference. The subjects included were composite materials and structures, aspects of strengthening of composites, metallic composites, glass reinforced plastics, composite pressure vessels, and composite systems for thermal protection. (W.L.H.)

**10739** SEP-234
Sylvania Electric Products Inc. Atomic Energy Div., Bayside, N. Y.
MONTHLY TECHNICAL PROGRESS REPORT FOR AUGUST 1956. Oct. 10, 1956. Decl. Feb. 4, 1960. 21p. Contract AT-30-1-GEN-366. OTS.

Hot-pressing and rolling techniques are being developed for the fabrication of porous fuel elements for high-temperature long burnup applications. Special methods of canning Th targets have been studied. Properties, hydriding conditions, and cladding of hydrides for use as potential moderators are being studied. The effect of diffusion of lattice imperfections upon the dimensional instability of $\alpha$-U is being studied. An attempt was made to prepare samples of $Ni_2Al_3$ in bulk form for use in diffusion studies by compacting and sintering Ni and Al powders. Metallurgical methods are being developed for preparing U-rich alloys which have a fine grain structure and are resistant to dimensional changes. The development of stacked fuel elements, non-oxide dispersion materials for fuel elements, and a Zircaloy and stainless steel cladding for fuel elements are discussed. (W.L.H.)

**10740** TID-5631
Brown Univ., Providence.
A STATISTICAL DESCRIPTION OF DISTRIBUTION OF PHASES. Technical Report No. 1. Dogan E. Gücer. Feb. 1960. 26p. Contract AT(30-1)-2394. OTS.

An attempt has been made to apply the theory of runs of mathematical statistics to the quantitative description of the state of distribution of phases. In a multi-phase alloy any deviation from the state of most probable distribution is taken as an indication of the presence of assignable causes in the statistical sense. From the metallurgical point of view these causes may be chemical, physical or mechanical in nature. Three states of distributions are distinguished: segregated, random, and dispersed. A statistical parameter is defined to indicate the degree of segregation or dispersion. This report deals with the theoretical considerations only. (auth)

**10741** WAPD-ZH-22
Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.
ZIRCONIUM HIGHLIGHTS. Jan. 1960. 20p. Contract AT-11-1-GEN-14. OTS.

The testing of Zircaloy at various stages of processing by ultrasonic techniques is described. A study was made to determine the feasibility of substituting ammonium bifluoride for the liquid hydrofluoric acid generally used in the etching processes required for the fabrication of Zircaloy fuel components. The addition of B to Zr results in a very strong alloy; however, they show little promise for being ductile. Zirconium–boron alloys can be hot forged. Boron is very detrimental to the oxidation behavior of Zircaloy-2. (W.L.H.)

**10742** WASH-143
Division of Reactor Development, AEC.
MINUTES [OF] AEC WELDING COMMITTEE MEETING [HELD AT] OAK RIDGE NATIONAL LABORATORY [ON] FEBRUARY 2 AND 3, 1953. Decl. Feb. 16, 1960. 162p. OTS.

Aspects of type 347 stainless steel welding are discussed, including electrode development, occurrence of cracks and fissures, corrosion, and a particular Hanford corrosion problem involving metallic-arc welds. Methods for welding of stainless steel pipes were discussed including the pressure-backed butt method, a procedure developed at Oak Ridge for fabrication of pipes for the HRE, tungsten-arc welding, and the Kellogg and Crane procedures for pipe welding without backing rings. A brief outline of welding development programs currently being conducted at KAPL (concerned mostly with type 347 stainless steel) is also presented. Cone-arc welding, which has been found applicable to tube-to-header heat-exchanger assemblies involving small pipes, and a concurrent project, the evaluation of high-temperature brazing alloys are discussed, and some of the welding problems connected with the HRP are briefly described. (L.M.T.)

**10743** WCAP-1376
Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.
THERMOELECTRIC NUCLEAR FUEL ELEMENT. Third Quarterly Progress Report January 10, 1960. G. R. Kilp, A. Biancheria, P. V. Mitchell, and S. W. Sandberg. Feb. 1960. 31p. Contract AT(30-3)-500. OTS.

Thermoelectric materials were prepared for irradiation and fabrication studies, and techniques were developed for the preparation of some uranium-bearing thermoelectric materials. Additional apparatus was set up to handle an increase in samples requiring measurements of Seebeck coefficient, resistivity, and thermal conductivity of thermoelectric materials being processed in the various phases of the project. Results are listed from irradiation tests of PbTe, $Na_{0.05}U_{0.95}O_2$, ZnSb, $Bi_{0.05}Ge_{0.95}Te$, and $Li_{0.06}Ni_{0.94}O$. Two in-pile experiments were designed, one utilizing $UO_2$ as the heat source and one featuring cylindrical geometry which allows more accurate and complete measurements of test parameters. In the program to determine the thermoelectric and physical properties of swaged GeTe and PbTe it was found that during cold swaging, high densities (95 to 97% theoretical in the case of 304 stainless steel clads) are obtained at relatively low reductions; subsequent gains are minor at higher reductions in area, and that rapid recrystallization of swaged GeTe occurs when the cold-swaged rods are heated to 600°C. The relative strength of the cladding material used has an effect on the density that can be achieved by the cold-swaging process. For example, higher densities result from the use of stainless steel and copper clads on a given geometry than result from the use of aluminum. When swaged rods are heated, a reaction band occurs at the interface between 304 stainless steel and GeTe, the rate of reaction increasing as a function of temperature according to the $x^2 = KT$ law. Preliminary results from thermoelectric property studies of swaged PbTe and GeTe indicate that the electrical properties are normal with the exception of a somewhat low Seebeck coefficient of the GeTe. Swaged rod-type assemblies of PbTe were prepared for bench testing. Plate-type bench test assemblies of GeTe and PbTe are being constructed. In-pile assemblies of $Li_{0.06}Ni_{0.94}O$ and PbTe + 0.07% Bi were prepared for irradiation studies. (For preceding period see WCAP 1095.) (auth)

**10744** WCAP-1380
Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.
THERMOELECTRIC NUCLEAR FUEL ELEMENT PROGRESS REPORT NO. 19. G. R. Kilp, W. P. Blankenship, P. V. Mitchell, and S. W. Sandberg. Feb. 10, 1960. 23p. Contract AT(30-3)-500. OTS.

Higher as-pressed pellet densities were achieved by introducing double-end pressing action. Binary and ternary uranium compounds were prepared and pelletized using the double action. A new bonding eutectic is being tried for establishing good electrical contact between steel end disks and the pellets. Numerous electrical measurements were carried out on materials involved in irradiation and fabrication studies. Data are presented from irradiation studies of a ZnSb sample and samples of GeTe and PbTe. In-pile results are described for a series stack of annular PbTe wafers heated by fission of $UO_2$ packed in the core of the stack of wafers. Other experiments are underway at the Brookhaven reactor. Fabrication studies described include swaged PbTe, compatibility of PbTe with various cladding materials, a bench-test of rod-type PbTe, and a p-n-couple demonstration device. (J.R.D.)

**10745**
NEW USE FOR RADIOACTIVE TRACERS, CHECKING FURNACE ATMOSPHERES. A Simple Arrangement, Using $Kr^{85}$, Keeps Tab on Operation of Heat-treating Furnaces. C. O. Reiser (Arizona State Univ., Tempe) and K. L. Wilson (Boeing Airplane Co., Seattle). J. Metals 12, 234-5 (1960) Mar.

The use of $Kr^{85}$ for determining both the gas flow inside a heat-treating furnace and the concentration of the remaining original atmosphere at any time after a purging procedure has been initiated is described. (C.J.G.)

**10746**
PREPARATION OF THIN SELF-SUPPORTING CARBON FILMS. G. Dearnaley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Rev. Sci. Instr. 31, 197-8(1960) Feb.

A method is described for the preparation of self-supporting carbon films of thickness between 4 $\mu g/cm^2$ and 1 $mg/cm^2$ and areas up to 1.5 $cm^2$. Applications as targets, backings, and beam strippers are discussed. (auth)

**10747**
IMPROVEMENTS IN OR RELATING TO METHODS OF PROTECTING GRAPHITE SURFACES. Hugh Wilson Davidson and John Walter Ryde (to General Electric Co., Ltd.). British Patent 830,005. Mar. 9, 1960.

A method is given for protecting the graphite of gas-cooled reactors from corrosion by coolant. The surface to be protected is exposed to Ni carbonyl at room temperature to deposit Ni. A further heating treatment is given in an inert atmosphere. The process may be carried out in existing reactors. (T.R.H.)

## Corrosion

**10748** AERE-C/R-2853
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
CHEMICAL INVESTIGATIONS IN HIGH TEMPERATURE WATER LOOPS. J. K. Linacre and H. Morley. Nov. 1959. 130p. BIS.

The corrosion rate of a mild steel water loop was investigated, after thorough cleaning by sulfuric acid pickling, by following the rate of change of hydrogen concentration in solution. Suitable corrections for loss of hydrogen by leakage and by diffusion through the loop steel were applied. The loop water was controlled at a pH of 10 to 11 by addition of KOH and by ion exchange and kept at an operating temperature of 260°C. The corrosion rate was found to fall rapidly, from an initial value of >0.4 mg $dm^{-2}$ $hr^{-1}$ to 0.04 mg $dm^{-2}$ hr after 300 hr. The rate of release of corrosion products, estimated by collection in a purification unit, was of the order of $10^{-3}$ mg $dm^{-2}$ $hr^{-1}$. If the steel was unclean and initially covered with a layer of low temperature oxide, the initial corrosion rate was lower than for the clean steel, but the rate of release of corrosion products was greater by a factor of 10, even after 300 hr exposure. On admission of oxygen to the corroded steel system, some oxidation of the $Fe_3O_4$ corrosion film to $Fe_2O_3$ occurred, but the major action appeared to be further attack on the steel to form $Fe_3O_4$. On first adding oxygen and at high oxygen concentrations, the rate of reaction was proportional to the oxygen concentration and inversely proportional to the film thickness. The film thickness increased as reaction proceeded. The rate constants for mild steel were determined to be: $k = 275\ cm^3\ dm^{-2}\ hr^{-1}$ and $p = 80\ (cm^3\ dm^{-2})^2\ hr^{-1}$, and for stainless steel, $p = 3.2\ (cm^3\ dm^{-2})^2\ hr^{-1}$. In the case of stainless steel, chromate was formed in solution at a rate proportional to the hydroxyl ion concentration. A rate constant of 0.04 $hr^{-1}$ was determined. The transfer of permanent gases from solution in the loop water to the vapor phase of the steam pressurizer was studied in the mild steel loop, relative to direct pressurization, degassing, and gas absorption connections of loop and pressurizer. Results were analyzed in terms of a mechanism involving stripping of gas from the pressurizer liquid phase by steam bubbles rising from the immersed heater. (auth)

**10749** AFOSR-TR-59-76
Modena, Italy. Universita.
BASIC RESEARCHES IN METAL CORROSION. Technical (Final) Report. Giuseppe Bianchi. Apr. 30, 1959. 10p. Contract AF61(052)-85.

The electrochemical processes of $O_2$ and $H_2O_2$ on platinum, graphite, and gold electrodes have been studied to get a knowledge of the mechanism of oxygen corrosion. The nature of the cathode affects the cathodic processes of oxygen and hydrogen peroxide reduction in acid and neutral solutions; moreover the platinum, the graphite, and the gold are absolutely different also from the point of view of their catalytic activity for the decomposition of hydrogen peroxide in acid solutions. The process of oxygen and hydrogen peroxide reduction in alkaline solutions takes place, independently of the nature of the cathode, at tensions very near the reversible one corresponding to the process: $O_2 + H^+ + 2e = HO_2^-$. (auth)

**10750** ANL-5546
Argonne National Lab., Lemont, Ill.
SUMMARY OF CORROSION INVESTIGATIONS ON HIGH-TEMPERATURE ALUMINUM ALLOYS. [Period covered]: February 1955—October 1956. C. R. Breden and N. R. Grant. Feb. 1960. 70p. Contract W-31-109-eng-38. OTS.

Tests were performed on aluminum alloys to evaluate their behavior in high-temperature, high-pressure, water-cooled and -moderated nuclear reactor environments. Test equipment, sample preparation, and test procedures are discussed. Aluminum—nickel alloys were found resistant to disintegration for periods up to 60 days in dynamic water at 600°F. The corrosion rates of the aluminum alloys M-388 and X-2219 at 600°F were found to be too high to merit consideration for cladding materials. The influence of pH, gas content, and velocity of the water on the corrosion of the above alloys was evaluated. Hydrogen addition at startup appeared to increase the degree of corrosion attack on the M-388 alloy. Irradiation tests on aluminum—nickel alloys revealed that the corrosion rate increased with distance from core. In-reactor samples of M-388 exhibited less corrosion attack than out-of-reactor samples. Boiling water corrosion tests were performed on M-388 for 1612 hr at 422°F with an average heat flux of 25,000 Btu per hr-$ft^2$. The over-all corrosion rate was 2.9 mil per yr. It is concluded that the corrosion rate of M-388 is acceptable for the specified test conditions: (1) absence of radiation; (2) demineralized water at 422°F; and (3) heat transfer rates not exceeding 40,000 Btu per $ft^2$. No accelerated corrosion attack due to boiling heat transfer and no significant buildup of corrosion products on heat transfer surfaces were noted. Accelerated corrosion of M-388 was noted when coupled with Type 304 stainless steel and exposed to tap water at room temperature, or air-saturated, demineralized water at 680°F. A technique for stripping corrosion films from aluminum and aluminum—nickel alloys is given. (C.J.G.)

**10751** HW-62466
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
PROTECTION OF CARBON STEEL FROM ATMOSPHERIC CORROSION. Interim Report No. 1. Lyle D. Perrigo and R. G. Moles. Oct. 22, 1959. 8p. Contract AT(45-1)-1350. OTS.

Carbon steel coupons, similar in chemical properties to those proposed for use in the NPR, were exposed for two months under conditions of Hanford weather or the atmosphere of a humidity oven at 150°F. Coupons coated with a proprietary compound rusted insignificantly while the unprotected samples rusted severely in the Hanford climate, and to a less degree in the humidity oven. (J.R.D.)

**10752** HW-62604
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
FISSION PRODUCT RELEASE BY THE HIGH TEMPERATURE URANIUM-STEAM REACTION. A. J. Scott. Nov. 18, 1959. 38p. Contract AT(45-1)-1350. OTS.

Fission product release in steam from cylinders of low level irradiated natural U was measured at 620 to 1440°C and at atmospheric pressure. Of the I, Te, and Xe, 80, 60, and 50%, respectively, were estimated to be released from 100% oxidation of the U in steam at 1440°C. For these same conditions maximum release of other elements was estimated as 3% Cs, 1% Ru, and ≤ 0.3% for non-volatile Sr, Ba, and Zr. The deposition pattern of released fission products was measured and the efficiency of one type absolute filter medium evaluated. Condensation of the steam atmosphere carrying the fission products was shown to be ≥ 98% efficient for removing I and Te from the off-gas. The $UO_2$ formed by the uranium-steam reaction was shown to retain significant amounts of I, Te, and Xe even after prolonged heating at 1440°C. Data obtained by analyzing the residual oxide and unreacted U provided a means for estimating the diffusion coefficients of the volatile isotopes at 1100°C. These were $6 \times 10^{-9}$ $cm^2$/sec for I, $3 \times 10^{-8}$ $cm^2$/sec for Te, and $5 \times 10^{-8}$ $cm^2$/sec for Xe. Reaction rates for U with steam at six temperatures from 620 to 1440°C were measured and activation energies determined as 8.8 kcal/g-mole below the U melting point, and 18 kcal/g-mole above the melting point. Trace irradiation of the U did not change the reaction rate with steam. (auth)

**10753** NAA-SR-Memo-4943
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
COMPATIBILITY OF U–10 Mo WITH 304 STAINLESS STEEL AT 1000°F. R. S. Neymark. Feb. 3, 1960. 7p. OTS.

A study was made to evaluate the compatibility of stainless steel clad U–10 wt.% Mo fuel with Na and NaK bands at 1000°F. No evidence of interalloying between the U–10 wt.% Mo fuel and the Type 304 stainless steel cladding was found. Exposures were made with Na and NaK bands for 744 and 2184 hours. (W.L.H.)

**10754** NACA-RM-E57G-18
Lewis Flight Propulsion Lab., Cleveland.
NONMETALLIC MATERIAL COMPATIBILITY WITH LIQUID FLUORINE. Harold G. Price, Jr. and Howard W. Douglass. Oct. 2, 1957. 8p.

Static tests were performed at −320°F and atmospheric pressure and at −320°F and 1500 pounds per square inch gage. These tests showed less reactivity than was observed in previous tests with gaseous fluorine. In general, it was found that reactivity decreased as temperature and pressure decreased. (auth)

**10755** NP-8389
[Aktiebolaget Atomenergi, Stockholm].
SWEDISH RESEARCH ON ALUMINIUM REACTOR TECHNOLOGY. Björn Forsén. 1959. 12p. (S-8).

For presentation at the EAES-Symposium on Reactor Materials, Saltsjöbaden, Stockholm, October 5–9, 1959.

A review of aluminum alloy development and corrosion testing in Sweden is presented. The mechanism and kinetics of aluminum corrosion by water are also discussed. (J.R.D.)

**10756** NP-8477
[Union Carbide Metals Co.], Niagara Falls, N. Y.
LITERATURE SURVEY OF THE CORROSION BEHAVIOR OF TANTALUM, ZIRCONIUM, AND TITANIUM. R. A. Perkins. Feb. 23, 1955. 21p.

The corrosion behavior of Ta, Ti, and Zr in inorganic acids, bases, chlorides and miscellaneous salts, waters and gases, and organic acids and miscellaneous organic chemicals is summarized. (W.L.H.)

**10757** SCTM-7-60(16)
Sandia Corp., Albuquerque, N. Mex.
PROTECTING MAGNESIUM FROM CORROSION. Vernon E. Arnold and Shary D. Holmes. Jan. 19, 1960. 16p. OTS.

Methods of control of corrosion in magnesium are reviewed and evaluated. The recommended anticorrosion treatment for magnesium consists of electrolytic anodizing (Dow-17 process), application of a wash primer than a corrosion-inhibiting primer, and a vinyl or vinyl-alkyd top coat. (C.J.G.)

**10758** TID-3548
Technical Information Service Extension, AEC.
ZIRCONIUM CORROSION. A Literature Search. William E. Bost, comp. Mar. 1960. 34p. OTS.

Results of a literature search comprising references to 317 unclassified reports and published literature on corrosion of zirconium in various media are presented. The report references are listed alpha-numerically after the name of the issuing agencies. Published references are arranged chronologically and by journal name. Most listed reports may be examined in AEC depository libraries. (J.R.D.)

**10759**
MASS TRANSFER IN LIQUID–LITHIUM SYSTEMS. William N. Gill, Richard P. Vanek, Robert V. Jelinek, and C. S. Grove, Jr. (Syracuse Univ., N. Y.). A.I.Ch.E. Journal 6, 139-44(1960) Mar.

The behavior of type-304 stainless steel in a forced-convection closed-loop lithium system was investigated over a wide range of temperatures and velocities. Fundamental information concerning the mechanism for mass transport was obtained by examining solution and deposition effects along flat plates. The rate-determining process for solution is transport from the solid to the interface, whereas deposition rates are liquid-phase controlled. Liquid-phase mass transfer coefficients were correlated with a maximum deviation of approximately 15% by the use of van Kàrmàn's analysis of the turbulent boundary layer along a flat plate, combined with the Chilton-Colburn empirical modification of the Schmidt group. Mean values of the solution rate constants ranged from 0.154 to $0.750 \times 10^{-5}$ cm/sec at 510 to 612°C. These values are on the order of $10^3$ smaller than corresponding liquid-phase mass transfer coefficients. (auth)

**10760**
COMBATING CORROSION IN MOLTEN EXTRACTION PROCESSES. H. Susskind, F. B. Hill, L. Green, S. Kalish, L. Kukacka, W. E. McNulty, and E. Wirsing (Brookhaven National Lab., Upton, N. Y.). Chem. Eng. Progr. 56, No. 3. 57-63(1960) Mar.

The results of corrosion tests performed on steels, stainless steel, nickel alloys, tantalum, molybdenum, gold, and ceramics in isothermal and nonisothermal exposures to corrodents for 1000 to 2500 hr at 500°C are given. The corrodents tested were a NaCl–KCl–$MgCl_2$ eutectic and a Bi–U fuel eutectic, both with and without additions of $BiCl_3$. The tests performed were static and tilting furnace capsule tests and thermal convection and forced circulation loop tests. (C.J.G.)

**10761**
THE OXIDATION OF ALUMINIUM IN DRY OXYGEN IN THE TEMPERATURE RANGE 400–650°C. D. W. Aylmore, S. J. Gregg, and W. B. Jepson (Univ. of Exeter, Can.). J. Inst. Metals 88, 205-8(1960) Jan.

The kinetics of the oxidation of high-purity aluminum sheet in dry oxygen at 7.6 cm pressure was studied at a series of fixed temperatures ranging at 50° intervals from 400 to 650°C. The oxidation runs were continued for periods of at least 170 hr and at 450°C for 400 hr. The oxidation at 400°C, apart from the first 2 hr, followed a parabolic rate law, while the curves of weight gain against time for the higher temperatures consisted of three distinct branches over which the rate respectively decreased, was constant, and decreased again to a very small value, $\sim$0.05 $\mu$g/cm$^2$ hr. The weight gains after 170 hr oxidation were smaller the higher the temperature, apart from the 400 and 650°C runs. The results are interpreted in terms of a crystallization of an initially formed amorphous oxide layer; this model is consistent with the electron-diffraction investigations of other workers. (auth)

## Fabrication

**10762** AD-229022
Illinois Inst. of Tech., Chicago. Armour Research Foundation.
BRAZING OF HEAT-RESISTANT METALS. N. Bredzs and H. Schwartzbart. Oct. 23, 1959. 93p. ARF Project No. B-039. Contract DA-11-022-ORD-957.

A program of research to study two phenomena important in the brazing of high-temperature alloys is described. These phenomena are dissolution of base metal in the molten filler metal, and penetration of filler metal into the grain boundaries of the base metal. The experimental approach utilized pad tests in which a pellet of filler alloy was melted on the base metal during a vacuum furnace brazing cycle, with 15 minutes at temperature. The range of filler alloys included Fe–B eutectic, Fe–Si eutectic, Ni–B eutectic, Ni–Si eutectic, Pd–B eutectic, Fe–Ge eutectic, Ni–Ge eutectic, and Fe–C–B alloy. Base metals included Armco iron, SAE 1045, high-carbon steel, 304 stainless steel, 410 stainless steel, 15PH-7Mo stainless steel, nickel, and 80% Ni–20% Fe alloy. Only the Fe–B filler alloy showed a great tendency to grain boundary penetration: in plain carbon steels to an increasing extent with increasing carbon content, and in stainless steels if chromium were present. The role of secondary diffusion processes in influencing grain boundary penetration was shown. In general, Ni–B will penetrate grain boundaries of the base metal if it picks up Fe by dissolution of base metal. Pd–B did not penetrate base-metal grain boundaries, but did dissolve extensive quantities of base metal at 2150°F. Fe–Si formed extremely brittle alloy layers at the base metal-filler metal interface. (auth)

**10763** ANL-5963
Argonne National Lab., Lemont, Ill.
THE MANUFACTURE OF THE GRAPHITE–URANIA FUEL MATRIX FOR TREAT. Final Report—Metallurgy Program 7.6.9. J. H. Handwerk and R. C. Lied. Jan. 1960. 26p. Contract W-31-109-eng-38. OTS.

The fabrication of the graphite–urania fuel blocks to be used in the Transient Reactor Test is described. A flowsheet of the fabrication process and an evaluation of the fabricated blocks are presented. (C.J.G.)

**10764** BMI-1363
Battelle Memorial Inst., Columbus, Ohio.
CENTRIFUGAL CASTING OF ALUMINUM–URANIUM ALLOYS. Norman E. Daniel, Ellis L. Foster, Jr., and Ronald F. Dickerson. July 20, 1959. Decl. Feb. 8, 1960. 24p. Contract W-7405-eng-92. OTS.

Centrifugal-casting techniques were investigated as a method of producing hollow cylindrical extrusion billets of aluminum–35 wt.% uranium. Among the variables evaluated were melt temperature, mold and pouring-spout configurations, mold speed, and method of pouring. With the equipment employed it was found that the best castings were produced utilizing a pouring temperature of 2400°F, a heavy-walled steel cylinder rotating between 700 and 900 rpm for the mold and a bottom-pouring technique employing a retractable pouring spout. Sound, nonporous billets 26 in. long and 5 in. in diameter were produced with a yield after machining of over 75% of the original charge. The major losses occurred in the pouring spout-and-cup assembly. This loss is relatively unaffected by the casting length; and, therefore, castings of greater length than 26 in. should result in even greater recoveries. (auth)

**10765** BRB-21
Bridgeport Brass Co., Conn.
EXTRUSION OF URANIUM FOR HANFORD CORED SLUG PROGRAM—VIII. G. T. Murray and R. M. Treco. Sept. 15, 1956. Decl. Feb. 4, 1960. 22p. Contract AT(30-1)-1405. OTS.

A process for the extrusion of cored slugs was developed for tubes of specified straightness, dimensional tolerance, and freedom from cracks. Data are included on all cored slugs thus far extruded. (W.L.H.)

**10766** BRB-22
Bridgeport Brass Co., Conn.
EXTRUSION OF URANIUM FOR HANFORD CORED SLUG PROGRAM—IX. G. T. Murray and R. M. Treco. Aug. 10, 1956. Decl. Feb. 4, 1960. 29p. Contract AT(30-1)-1405. OTS.

A number of experiments are described involving extrusion of uranium tubing for HAPO cored slugs. Various techniques of extrusion and a number of tool modifications are analyzed in relation to the problem of improved tube concentricity. Despite various improvements, the maximum specified eccentricity of 0.032-inches cannot be consistently achieved. Another aspect of the extrusion problem is the duplex grain structure encountered. It is shown that this structure has its origin in one or more allotropic phase transformations occurring during the extrusion process. (auth)

**10767** BRB-23
Bridgeport Brass Co., Conn.
EXTRUSION OF URANIUM FOR HANFORD CORED SLUG PROGRAM—X. G. T. Murray and R. M. Treco. Sept. 1, 1956. Decl. Feb. 4, 1960. 46p. Contract AT(30-1)-1405. OTS.

An extensive series of extrusion experiments on tubes for HAPO cored slugs were made. The use of as-extruded tubes requires good concentricity if high metal yields are to be obtained. Based on the results of earlier work, the experiments were designed to improve concentricity by approaching ideal conditions of press and tool alignment. The results showed that for the particular slug required, press and tool alignment cannot be controlled adequately to consistently produce high metal yields, although much progress has been made in this direction. A re-examination of the slug finishing method is indicated in order to adjust the slug finishing process to an extruded product. Details of the extrusion experiments and their results are presented. (auth)

**10768** BRB-25
Bridgeport Brass Co., Conn.
MONTHLY PROGRESS REPORT FOR SEPTEMBER–OCTOBER 1955. Nov. 15, 1955. Decl. Feb. 4, 1960. 16p. Contract AT(30-1)-1405. OTS.

Tests to determine the effect of time on Zircaloy-2 immersed in a phosphate–fluoride bath showed 8 minutes to be the optimum time, although metal loss occurs after 2 minutes. Hot-rolled uranium swaged to 87% R.A. developed a preferred orientation in which (010) and (120) poles show the greatest change. Some refinements in the sine phi correction for diffracted intensities of uranium were introduced and reported. Proposed processes for fabricating uranium by extrusion, drawing, swaging and/or machining are outlined. (auth)

**10769** BRB-37
Bridgeport Brass Co., Conn.
MONTHLY PROGRESS REPORT FOR NOVEMBER–DECEMBER 1956. Mar. 1, 1957. Decl. Feb. 4, 1960. 53p. Contract AT(30-1)-1405. OTS.

An alpha extrusion of a 7-in.-diam. dingot billet to 0.850-in.-diam. rod was successfully performed at the high reduction ratio of 63 to 1 and showed promise in improving the surface quality. The extrusion of small $^{3}/_{8}$-in.-diam. rod from a 7-in.-diam. dingot billet was shown feasible in both the alpha and gamma phases by using multi-hole dies with a total extrusion ratio of 57 to 1. In a study of the effect of several extrusion variables on U rod surfaces it was determined that billets with sawed ends and 21-in.-long billets produced satisfactory results and that increasing the reduction ratio may improve the surface. A study of the various factors involved in the previous lack-of-drawability of extruded U rod indicated that warm drawing offered the greatest possibilities of improvement in drawability. A second dingot gamma extrusion of 15 billets at a temperature of 1700°F was made to 2.910-in.-diam. rod. Factors studied were die type, extrusion speed, and use of hot follower blocks. Initial results on the semi-production program are reported. In the C-2 extrusion for Savannah hollow slugs, work was halted after the sixth extrusion because of mandrel tip softening caused by excessive heat build-up from the 18-in.-long billets. (W.L.H.)

**10770** LA-2220
Los Alamos Scientific Lab., N. Mex.
WELDING OF PLUTONIUM. J. W. Anderson, R. Gilmore, W. D. McNeese, and A. Romero. May 9, 1958. Decl. Mar. 13, 1959. 13p. Contract W-7405-eng-36. OTS.

Delta-stabilized plutonium can be welded to itself or almost any other metal using the inert-gas metal-arc process. Equipment and procedures suitable for the welding of delta-stabilized plutonium under various conditions are described. (auth)

**10771** LMSD-480485
Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.
VACUUM MELTING OF BERYLLIUM BY ELECTRON BOMBARDMENT. H. T. Sumsion and C. O. Matthews. Dec. 1959. 41p. Contract NOrd-17017.

A process is described for melting and casting beryllium ingots by electron bombardment, in order to produce a beryllium or beryllium-alloy ingot for fabrication into plate. Results are furnished of visual inspections, metallographic examinations, chemical and x-ray-diffraction analyses, and machinability, hardness, tensile strength, and bend tests. The effects of variables in both the melt stock and the processes are reported. It is concluded that smooth, homogeneous ingots three inches in diameter and essentially free of casting defects can be produced by the process described. Vaporization loss during melting is not prohibitive for successful production. Ingots produced show improved cast structure and better machinability than induction-melted, vacuum-cast material. Oxide content is reduced but no significant increase in ultimate tensile strength, or decrease in metallic impurities, was obtained. A method of analysis by gamma activation was developed and proved effective for determinations of oxygen and carbon. (auth)

**10772** MIT-PL-12
Massachusetts Inst. of Tech., Cambridge.
FABRICATION OF ZIRCONIUM-CLAD URANIUM FUEL ELEMENTS. P. Loewenstein. Jan. 16, 1951. Decl. Feb. 4, 1960. 6p. OTS.

Zr-clad U rods are being produced on a small scale by simultaneous extrusion. A U billet is machined and the surface carefully prepared by pickling. An extruded Zr tube is shrunk or pushed on the U slug. The assembly is machined to give the proper thickness of cladding and is then extruded in a protective jacket. The jacket is removed chemically or mechanically, and the element is given a slight cold finish by swaging to obtain surface and dimensional tolerances. Even claddings are obtained, and mechanical and thermal cycling tests show that a strong bond exists. (J.R.D.)

**10773** NAA-SR-4874
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
DEVELOPMENT AND PRODUCTION OF URANIUM 10 wt.% MOLYBDENUM AS-CAST SLUGS FOR HNPF PHYSICS EXPERIMENT. J. A. Stanley and M. H. Binstock. Apr. 1, 1960. 32p. Contract AT-11-1-GEN-8. OTS.

A multiple casting process was developed for the production of 0.590 ± 0.005-in. diam. by 12-in. long solid right cylinders. The process involves vacuum induction melting in $MgZrO_3$ coated graphite crucibles and casting into coated graphite molds. Thirty-eight hundred fifty 90 wt.% U of 3.5 wt.% enrichment—10 wt.% Mo as-cast pins were produced for HNPF Exponential Experiments. (auth)

**10774** NAA-SR-4904
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
PROCESS DEVELOPMENT OF URANIUM MONOCARBIDE FUEL SLUGS. Interim Report. D. H. Turner. Mar. 15, 1960. 20p. Contract AT-11-1-GEN-8. OTS.

Stoichiometric uranium monocarbide was prepared by nonconsumable electrode arc melting of uranium-carbon charges, by carbothermic reduction of uranium-carbon charges, and by carbothermic reduction of uranium dioxide. The fabrication processes investigated include nonconsumable-electrode skull casting, induction melting and casting, and hot pressing. Skull cast uranium monocarbide slugs of seven-eights inch diameter by four inches long were made. The economics of the fabrication processes is discussed. (auth)

**10775** NMI-1228
Nuclear Metals, Inc., Concord, Mass.
YTTRIUM FABRICATION. E. S. Guidoboni, A. M. Huntress, and P. Loewenstein. Oct. 26, 1959. 58p. Contract AT(30-1)-1565. OTS.

Methods for hot breakdown of large diameter yttrium castings and for production of semi-finished shapes by extrusion, rolling, swaging and drawing are described. A preliminary investigation revealed that vacuum annealing at 1100°F is satisfactory for softening cold worked material. The oxidation of bare yttrium metal was observed to be quite rapid at temperatures above 900°F. The formation of copper-yttrium compounds at extruded interfaces was also observed to occur at temperatures as low as 950°F. (auth)

**10776** NP-8382
[Aktiebolaget Atomenergi, Stockholm].
SOME OBSERVATIONS CONCERNING CRACK FORMA-

TIONS IN $UO_2$-BODIES. Ulf Runfors and K. E. Jansson. 1959. 14p. (S-1).

For presentation at the EAES-Symposium on Reactor Materials, Saltsjöbaden, Stockholm, October 5-9, 1959.

Methods of eliminating cracks in fabrication of $UO_2$ cylinders are discussed. Cracks in pressed pellets can be eliminated by counter pressure when the pellet issues from the dye and by suitable dye tapering. Cracks in sintered pellets can be avoided by preventing too-fast lubricant evaporation. (J.R.D.)

**10777** NP-8383
[Aktiebolaget Atomenergi, Stockholm].
SOME OBSERVATIONS ON THE SINTERING OF NON-STOICHIOMETRIC $UO_2$ IN DIFFERENT ATMOSPHERES. B. Nordström and U. Runfors. [1959]. 18p. (S-2).

For presentation at the EAES-Symposium on Reactor Materials, Saltsjöbaden, Stockholm, October 5–9, 1959.

Sintering of non-stoichiometric $UO_2$ was studied in argon, hydrogen, and water vapor. Sintering in water vapor produces maximum densities at 1250°C. Effects of oxygen content on sintering were studied and data on various parameters affecting sintering are presented. (J.R.D.)

**10778** NP-8384
Aktiebolaget Atomenergi, Stockholm.
GRINDING OF URANIUM DIOXIDE PELLETS. Ulf Runfors and Bertil Filipson. Aug. 26, 1959. 16p. (S-3).

For presentation at the EAES-Symposium on Reactor Materials, Saltsjöbaden, Stockholm, October 5–9, 1959.

Techniques used in grinding $UO_2$ are described, and results of experiments which indicate the importance of grinding wheel selection and maintenance are given. Design of a plant for grinding is included. (J.R.D.)

**10779** NP-8385
Aktiebolaget Atomenergi, Stockholm.
FABRICATION FOR THE R3/ADAM FUEL ELEMENTS. Hilding Mogard and Bengt Nelson. [1959]. 18p. (S-4).

For presentation at the EAES-Symposium on Reactor Materials, Saltsjöbaden, Stockholm, October 5–9, 1959.

The fabrication procedure for R3/Adam fuel elements is described. Fuel elements of sintered natural $UO_2$ pellets enclosed in Zircaloy-2 cans are scheduled for production in a newly designed plant. (J.R.D.)

**10780** NP-8390
[Aktiebolaget Atomenergi, Stockholm].
PRODUCTION SINTERING OF $UO_2$. Lars Halle. [1959]. 38p. (S-9).

For presentation at the EAES-Symposium on Reactor Materials, Saltsjöbaden, Stockholm, October 5–9, 1959.

A plant for production of sintered $UO_2$ pellets from oxide powder is described. Results of sintering about 9 lb of $UO_2$ pellets are given. Safety measures are listed. (J.R.D.)

**10781** NYO-2685
Olin Mathieson Chemical Corp. Metallurgical Labs., New Haven.
FUEL CYCLE DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT [FOR] OCTOBER 1 TO DECEMBER 31, 1959. Jan. 27, 1960. 44p. Contract AT(30-1)-2374. OTS.

Work was continued on developing a process for the fabrication of uranium oxide fuel pellets by an inert atmosphere low-temperature sintering method. Oxidation rate and sintering studies for two oxides produced by Shattuck were completed. Using Davison and Spencer ADU oxides, an investigation of the effect of sintering cycle, mainly sintering temperature and soaking time, on sintered properties of non-stoichiometric $UO_2$ was undertaken. Results showed that it is possible to sinter non-stoichiometric $UO_2$ compacts to yield high densities and remove excess oxygen at the same time by sintering in nitrogen at 1300°C. Two methods of preparing UC were investigated. The powder consolidation approach involved the investigation of the reaction of uranium hydride with methane for preparation of the powder and cold pressing and sintering of the product. Arc melting of the component elements was the other method investigated. The optimum time and temperature were determined for the reaction of the methane with uranium hydride. Various compacting lubricants, compacting pressures, sintering times, and temperatures for the UC powder were investigated. Conditions were established for arc melting homogeneous 200 g UC buttons. Sound uniform bodies of UC $^3/_8$'' in diameter and $^3/_4$'' in length were produced by melting buttons in graphite molds. (For preceding period see NYO-2684.) (W.D.M.)

**10782** TID-5629
Stevens Inst. of Tech., Hoboken, N. J. Powder Metallurgy Lab.
SLIP CASTING OF NUCLEAR FUEL ELEMENTS. Report No. 3. Gregory J. Comstock, Edward H. Baron, Frances H. Clark, and Edmund B. Wilson. Mar. 15, 1960. 11p. Contract AT(30-1)-2258. OTS.

An investigation of liquid phase sintering as a means of achieving solid density in slip cast stainless steel was started. Minus 100 mesh type 316 spherical stainless steel powder was sintered to 98% relative density in 1 to 2 hours at 1225°C, with the liquid phase supplied by 10 wt. % Nicrobraz powder dispersed in the casting. Because of the high boron content of the brazing alloy, a two phase microstructure resulted which was not influenced by water quenching. Extensive grain growth (to ASTM 2) occurred during densification. (auth)

**10783** TID-7571(p.247-52)
Westinghouse Electric Corp. Aviation Gas Turbine Div., Kansas City, Mo.
BLENDING OF CAST SHOT USING A RADIOISOTOPE. Francis M. Winterburg. 6p.

A radioisotope was added to one melt of molten alloy and cast into shot. This radioactive shot was then added to eight other melts of nonactive shot and blended in a mechanical mixer. Shot samples were assayed to determine the uniformity of blending. A few round bars were poured from the radioactive melt, and thin wafers were cut from these bars. These wafers were assayed and also used to make autoradiograms to determine the distribution of the radioisotope in the radioactive melt. (auth)

**10784** YAEC-156
Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.
FABRICATION OF A SILVER–INDIUM–CADMIUM ALLOY CONTROL ROD FOR THE YANKEE CRITICAL EXPERIMENTS. J. R. Dazen. Feb. 1960. 25p. For Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1.

An alloy of 80% silver–15% indium–5% cadmium is being considered as the absorber material for control rods in the Yankee Atomic Electric Company's nuclear power plant. The fabrication of a control rod containing an 80% Ag–15% In–5% Cd absorber section for use in the Yankee critical experiments is presented in detail. Also, the nuclear and metallurgical properties of 80% Ag–15% In–5% Cd are reviewed. (auth)

**10785**
HEAVY CONCRETE MIXED IN TRANSIT. Norman Posner

(Stone & Webster Engineering Corp., New York). Eng. News-Record 162, 3p. (1959) Nov. 26.

The fabrication of concrete blocks containing ilmenite for the Brookhaven synchrotron shield is discussed. Mixing conditions and physical properties of the concrete are given. (C.J.G.)

**10786**

FABRICATING EQUIPMENT WITH ZIRCONIUM. Burton S. Payne (Pfaudler Permutit Inc., Rochester, N. Y.). Ind. Eng. Chem. 52, No. 3, 45A-6A(1960) Mar.

Welding techniques used to fabricate zirconium are discussed. The equipment used in the welding processes is described. (C.J.G.)

**10787**

NUCLEAR FUEL ELEMENTS. Henry H. Hausner and James F. Schumar, eds. New York, Reinhold Publishing Corporation, 1959. 420p.

Fabrication techniques for various types of fuel elements are discussed. The economics of fabrication and reprocessing are included. The high-temperature creep of uranium-loaded graphites is discussed. Fuel element corrosion in water and radiation effects on fuel elements are discussed. (C.J.G.)

**10788**

IMPROVEMENTS IN METAL WELDING METHODS. (to Commissariat à l'Énergie Atomique). British Patent 830,471. Mar. 16, 1960.

An electron-beam welding method is offered. (T.R.H.)

## Properties and Structure

**10789** AD-214829

Stanford Research Inst., Menlo Park, Calif.
MECHANICAL PROPERTIES AND OXIDATION RESISTANCE OF CERTAIN REFRACTORY METALS. Final Report [for] February 1—December 31, 1958. T. E. Tietz, B. A. Wilcox, and J. W. Wilson. Jan. 30, 1959. 238p. SRI Project SU-2436. Contract NOas-58-366-d.

The tensile, creep, oxidation, and thermal properties of Cr, Nb, Os, Re, Ta, W, and V were studied at temperatures varying from −200 to 2500°C. Data are compiled on the transition temperature for ductile-brittle behavior, ductility and workability, and constitution of alloys. (C.J.G.)

**10790** AFOSR-TN-60-168

Hebrew Univ., Jerusalem.
OPTICAL PROPERTIES OF PARAMAGNETIC SOLIDS. Technical Note No. 10. W. Low. Aug. 1959. 29p. Contract AF61(052)-59.

The transition groups show absorption and fluorescence spectra characteristic of the particular ion and of the crystal surroundings. These absorption bands and lines are transitions between the Stark levels of the ground state and the Stark levels of the excited states. This article discusses ways in which the energy level schemes can be calculated for various symmetries. It is shown that good agreement between experiment and theory can be obtained by using only a few parameters. A review of the measured f numbers and fluorescent decay times as well as the theoretical background is presented for the iron and rare earth group. Certain regularities are shown to exist in the intensities of the absorption lines and line width of these transition groups. (auth)

**10791** BMI-1388

Battelle Memorial Inst., Columbus, Ohio.
EFFECTS OF TERNARY ADDITIONS OF ALUMINUM-35 w/o URANIUM ALLOYS. Norman E. Daniel, Ellis L. Foster, and Ronald F. Dickerson. Oct. 27, 1959. Decl. Feb. 3, 1960. 31p. Contract W-7405-eng-92. OTS.

The effects of a number of ternary additions on the constitution, casting, and fabricating characteristics and the physical properties of aluminum—35 wt.% uranium were investigated. Initial investigations were concerned with the effects of 3 at.% ternary additions on the microstructure and press-forging characteristics of the alloy. It was found that additions of this magnitude often introduced extrinsic phases in the alloy. At the 3 wt.% level, additions of germanium, silicon, tin, or zirconium inhibited the formation of $UAl_4$ and thereby increased the extent of the aluminum matrix in the alloy. It was also noted that these additions decreased the pressures required for extruding, and the tin addition also improved the homogeneity of cast shapes. Lead and palladium also improved the homogeneity of the cast material; however, neither of these was an effective inhibitor of $UAl_4$ and free lead was detected in the alloy to which lead had been added as the ternary. From these studies it appears that tin and zirconium are as effective as silicon in enhancing the fabricating characteristics of aluminum—35 wt.% uranium alloys, and may prove superior when evaluated on the bases of casting qualities and recycling characteristics. (auth)

**10792** BMI-1426

Battelle Memorial Inst., Columbus, Ohio.
THE DIFFUSION OF HYDROGEN IN ZIRCONIUM HYDRIDE. William M. Albrecht and W. Douglas Goode, Jr. Mar. 3, 1960. 11p. Contract W-7405-eng-92. OTS.

The diffusion of hydrogen in zirconium hydride was studied using permeation techniques. The rate of permeation of hydrogen through zirconium hydride disks was measured for small concentration gradients. Data were obtained at 61 to 65 at.% hydrogen and 500 to 750°C. The diffusion coefficients were determined by the time-lag method. No variation of the diffusion coefficients with hydrogen concentration was observed. The diffusion coefficients can be expressed by $D$ (cm$^2$ per sec) = 599 exp (−34,800/RT). (auth)

**10793** BNL-4648

Brookhaven National Lab., Upton, N. Y.
LOW VOLUME CHANGE CONCRETE STUDIES. John H. Lancaster. Jan. 22, 1958. 5p. (ADD-JHL-7). OTS.

Curves are presented which show the percent expansion versus time in months for Brand No. 1 cement with three local aggregates. An aggregate is generally considered to be deleteriously reactive if the linear expansion exceeds 0.100% within 365 days and as the data give an expansion of less than 0.002% at 365 days, it is concluded that there is practically no possibility of reactivity. (W.D.M.)

**10794** CAL-KA-1289-M-6

Cornell Aeronautical Lab., Inc., Buffalo.
IMPROVEMENT OF Cr—Ni—Mo IRON BASE ALLOYS BY VACUUM MELTING AND CASTING. Final Report. Franklin J. Gillig. Sept. 30, 1959. 16p. Contract NObs-77019.

The effects of minor changes in composition and vacuum melting on the high temperature mechanical properties of iron base alloys containing 20 Cr- 20 Ni- 5 Mo and various minor additions of Nb, W, Ti, B, and Al were investigated. Twenty-one heats were cast with varying compositions. The 100-hour rupture strength at 1500°F was used as the basis for rating the elevated temperature strength. The strength of the base line heat was not surpassed by any appreciable amount but equivalent strengths were obtained with several compositions which were leaner in alloying elements. (auth)

**10795** CRMet-838
Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.
CREEP AND TENSILE PROPERTIES OF Mg−0.75Ce−0.5Zn−0.5Zr and Mg−6.5Al−1Zn. L. G. Bell. Jan. 1960. 38p. (AECL-969). AECL.

The creep properties of the alloy Mg−0.75Ce−0.5Zn−0.5Zr were determined at 50 and at 80°C under various stresses and also at 7500 psi and various temperatures up to 300°C. Samples for creep testing were cut transversely or longitudinally from extruded tube. Extrapolation of minimum creep rates indicates that at 50°C the alloy will attain a minimum creep rate of $1 \times 10^{-5}$ %/hr at 12,500 psi; at 80°C the corresponding stress is 9,500 psi. The creep strength in the transverse direction is somewhat less than in the longitudinal direction. The ultimate tensile strengths of extruded tube at 50°C and at 80°C were found to be 28,000 and 25,000 psi, respectively and, considering that the working stress must be ¼ of these values, they are the limiting factor in pressure tube design. Some tests on alloy Mg−6.5Al−1Zn at 50°C showed that the creep strength of this alloy is almost the same as that of AZ61. A creep rate less than $10^{-5}$ %/hr is met by this alloy at 7,500 psi. (auth)

**10796** KAPL-408
Knolls Atomic Power Lab., Schenectady, N. Y.
A NOTE ON THE DUCTILITY OF BETA URANIUM. A. N. Holden. Sept. 28, 1950. 10p. Contract W-31-109-Eng-52. OTS.

In an investigation of the ductility of beta U it was found that this is not a brittle phase. It deforms readily by slip on at least one system and may be hot worked if temperatures are controlled so that transformations are avoided. (J.R.D.)

**10797** KAPL-460
Knolls Atomic Power Lab., Schenectady, N. Y.
METALS COMPARATOR TESTING OF HANFORD URANIUM SLUGS. D. W. White. Jan. 9, 1951. Decl. Feb. 4, 1960. 42p. Contract W-31-109-Eng-52. OTS.

It has been found that the Metals Comparator can effectively measure the extent to which a bare uranium slug has been transformed to a $\beta$ heat-treated structure. The sensitivity and reliability of the method, as well as its simplicity and speed of performance, favor its use as a production test for routine inspection of bare slugs. The adjustments and conditions for optimum performance of the instrument are described. Acceptance specifications are given. The Metals Comparator cannot be applied satisfactorily to the testing of aluminum-canned slugs, however. Slight but acceptable variations associated with the jacketing affect the test results to such an extent that they tend to camouflage the effects of transformation differences. (auth)

**10798** KAPL-2060
Knolls Atomic Power Lab., Schenectady, N. Y.
EFFECT OF COMBINED STRESS ON YIELD AND FRACTURE BEHAVIOR OF ZIRCALOY-2. R. L. Mehan. Sept. 15, 1959. 28p. Contract W-31-109-Eng-52. OTS.

The yielding and fracture characteristics of Zircaloy-2 as a function of stress state were investigated at room temperature through the medium of thin-walled cylindrical specimens under internal pressure and axial tension. Stress states from uniaxial longitudinal tension to uniaxial tangential tension were examined. Two tests at elevated temperature were performed at a single stress ratio. It was found that the fracture ductility lessened with increasing biaxiality. A minimum in ductility was found at balanced biaxial tension where the fracture ductility, as expressed by the effective strain, was 29%. The yielding and plastic flow properties were found to be highly anisotropic. Two methods were used to express the plastic flow data: a graphical approach and a theoretical analysis based on a theory proposed by R. Hill, either one of which is suitable to express the flow properties of Zircaloy-2 under various states of combined stress. Based on the results of this work, it was concluded that the effect of biaxial combined stress on the fracture ductility of Zircaloy-2 is not in itself sufficient to account for the low-ductility failures of fuel element claddings observed in some irradiation tests. (auth)

**10799** NAA-SR-3727
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
THE VAPORIZATION OF BERYLLIUM OXIDE. B. D. Pollock, A. M. Saul, and T. A. Milne. Mar. 15, 1960. 18p. Contract AT-11-1-GEN-8. OTS.

The volatilization of beryllium oxide was studied by use of the Knudsen method and a tungsten cell at 2123 to 2475°K. The degree of interaction of beryllia with tungsten was also determined by observing the amount of tungsten loss associated with the complete volatilization of a known amount of beryllium oxide. Previously published data, obtained by use of a mass spectrometer, were used to estimate the relative importance of various molecular species. Upper limits for the free energies of reaction of tungsten and monatomic oxygen to form $WO_2$(g) and $WO_3$(g) at 2242°K are −62.4 and −124 kcal, respectively. The importance of molecular beryllia was assessed by comparison of the measured rates of effusion of beryllium with those calculated for dissociation. The effusion experiment data are in agreement, within experimental errors, with mass spectrometric data taken at 2242°K and show a temperature dependence consistent with the mass spectrometrically determined heats of vaporization of the more important polymers. (auth)

**10800** NAA-SR-4432
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
THERMAL CYCLING TESTS OF POROUS URANIUM. L. E. Wilkinson. Mar. 15, 1960. 14p. Contract AT(11-1)-GEN-8. OTS.

Thermal cycling tests were conducted on porous uranium to determine the structural integrity of a fuel element. Thermal cycling from 100 to 500°C demonstrated that there was perhaps a slight advantage in the introduction of voids in the fuel. Under thermal cycling from 200 to 700°C, the porous fuel bodies showed less resistance to growth than did unalloyed, dense uranium. It is concluded that mechanical restraint would be necessary if this fuel were to be cycled into the beta phase, the operational limit in the alpha phase being <660°C. (auth)

**10801** NAA-SR-4509
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
MECHANICAL PROPERTIES OF STEELS FOR SODIUM SERVICE. W. J. Anderson. Mar. 15, 1960. 127p. Contract AT-11-1-GEN-8. OTS.

The physical and mechanical properties of eighteen alloy and stainless steels at room temperature to 1500°F are given. The data are presented in the form of graphs to show the effect of temperature. Prefacing each set of graphs is a listing of ASTM designations for the steel. Data on properties such as heat content, density, electrical resistivity, thermal expansion, thermal conductivity, short time tensile properties, impact strength, creep strength, stress-rupture strength, and fatigue strength are included. Information sources include the literature, technical publications of engineering societies, and manufactures' data sheets. Relationships between service conditions and conventional properties are discussed along with the general behavior of classes of steels. (auth)

**10802** NP-8387
[Aktiebolaget Atomenergi, Stockholm].
A SMALL IMPACT TEST SPECIMEN FOR IRRADIATION EXPERIMENTS. M. Grounes. Sept. 16, 1959. 16p. (S-6).

For presentation at the EAES-Symposium on Reactor Materials, Saltsjöbaden, Stockholm, October 5–9, 1959.

Difficulties encountered in measuring irradiation-induced susceptibility to brittle fracture are discussed and the advantages of using sub-size impact test specimens are pointed out. Dimensions of a proposed specimen are listed and preliminary results of Charpy impact testing are included. (J.R.D.)

**10803** NP-8388
[Aktiebolaget Atomenergi, Stockholm].
METALLURGICAL VIEWPOINTS ON THE BRITTLENESS OF BERYLLIUM. Göran Lagerberg. [1959]. 19p. (S-7).

For presentation at the EAES-Symposium on Reactor Materials, Saltsjöbaden, Stockholm, October 5–9, 1959.

The properties of beryllium are reviewed with emphasis on the deformation behavior of single crystals. The mechanical behavior of polycrystalline metal is also examined. (J.R.D.)

**10804** NP-8442
California. Univ., Berkeley. Minerals Research Lab.
A STUDY OF LOW TEMPERATURE CREEP MECHANISMS IN ALUMINUM SINGLE CRYSTALS. Technical Report No. 8. L. A. Shepard and J. E. Dorn. Sept. 18, 1959. 54p. Contract Nonr-222(49).

A study was made of the effects of small abrupt changes in stress and temperature upon the creep rate of aluminum single crystals at low temperatures. With an important exception, the results were found to be in agreement with the predictions of the dislocation intersection mechanisms. Whereas intersection theory predicts that the change in the logarithm of the strain rate with stress, $\beta = (\partial \ln \overset{0}{\gamma}/\partial \tau) = (\mathrm{const}/kt)$, $\beta$ was found experimentally to increase by a factor of 5 at 78 and 160°K. A qualitative model is offered to explain this behavior in terms of pile-ups of dislocations aiding intersection at the higher temperature. (auth)

**10805** NYO-7551
Tufts Univ., Medford, Mass.
AN X-RAY DIFFRACTION STUDY OF THE PALLADIUM–HYDROGEN SYSTEM AT ELEVATED TEMPERATURES AND UNDER HYDROGEN PRESSURE. Arnulf J. Maeland and Thomas R. P. Gibb, Jr. Jan. 25, 1960. 17p. Contract AT(30-1)-1355. OTS.

Debye-Scherrer patterns were obtained at 25 to 346°C and at hydrogen pressures of 0 to 33 atm. for the $H_2$–Pd system. The lattice parameters of the alpha-phase and the beta-phase are reported as a function of composition and temperature, both above and below the critical temperature. (auth)

**10806** NYO-8906
Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.
AN APPROACH TO THE STUDY OF SOLID STATE BONDING. Final Report [for] December 1958–November 1959. R. K. Steele and J. Kozol. Changed from OFFICIAL USE ONLY Mar. 16, 1960. 44p. Contract AT(30-1)-2302. (CEND-77). OTS.

A program to investigate the possible similarities between bond interfaces and grain boundaries is described. The criterion for establishing the similarity of a bond interface and a grain boundary is the migration characteristics of the boundary under the influence of controlled orientation, strain level, temperature, and time. In addition, the orientation dependency of the "threshold," or minimum deformation, for bonding may be determined at the same time. The bonding fixture and vacuum annealing equipment were constructed. All of the high-temperature metallographic equipment was received but is not completely assembled. Preliminary annealing studies revealed the desirability of having strain-free specimens prior to bonding. Therefore, a chemical polishing technique was developed which permitted the production of strain-free disc specimens. "Tilt" specimens became available just prior to the cessation of experimental activity. Exploratory evaluation of etch pitting and Laue techniques indicated that both were suitable for orientation determinations but could be used for strain level estimation only with qualifications. Although a bond specimen was prepared, the bond failed when disturbed and the experiment must be regarded as inconclusive. Additional bond was not prepared. (auth)

**10807** NYO-9000
Materials Research Corp., Yonkers, N. Y.
PERMEABILITY OF CLADDING MATERIALS TO INERT GASES. First Annual Report [for] November 15, 1958 to November 15, 1959. G. T. Murray and G. Pincus. Dec. 18, 1959. 28p. Contract AT(30-1)-2286. OTS.

The diffusivity of helium through aluminum was measured at 400 to 550°C by two different techniques. In the first of these an aluminum sheet cathode was charged with gas by bombarding it with helium ions accelerated by a 500 v d-c potential. Two charged strips were then bonded to form a diffusion sandwich such that the helium was contained within a thin center section. The gas was subsequently allowed to escape during an isothermal anneal. Diffusivities evaluated from measurements of the amount of escaped gas exhibited the expected temperature dependency. In the second technique gas was introduced homogeneously into a cylindrical specimen of an aluminum base lithium alloy by neutron irradiation. Some of the helium resulting from the transmutation of $Li^6$ atoms was subsequently diffused from the specimen by annealing, but the diffusivities measured by this technique did not vary with temperature in the expected fashion. It is believed that gas bubble formation during the diffusion anneal could have caused this behavior. (auth)

**10808** PA-TR-2624
Picatinny Arsenal. Feltman Research and Engineering Labs., Dover, N. J.
DETERMINATION OF ADHESIVE BOND STRENGTH TO RARE AND UNUSUAL METALS BY USING THIN FOILS. Raymond F. Wegman and Michael J. Bodnar. June 1959. 31p. DA Project No. 593-32-002.

The adhesive bond strength obtainable to rare and unusual metals was investigated using thin foils. Good adhesion was obtained between cold-rolled, low-carbon steel and the following metals: niobium, copper-beryllium alloy, molybdenum, palladium, rhenium, stainless steel, tantalum, tungsten, zirconium, and 720 alloy (alloy of copper, manganese, and nickel) at 73.5°F. These metals, in the form of thin foils, were bonded between standard button-type tensile pieces to form sandwich constructions. Test results show that the foil test method provides an efficient technique for obtaining tensile adhesion data to rare or expensive metals. Three types of adhesives were used to obtain adhesion data to the various metals: a styrene-unsaturated polyester, a modified bisphenol-A type epoxy, and a modified novolac-based epoxy. Good adhesion was obtained to all the metals tested even though the adherends were cleaned only by vapor degreasing. On the basis of the highest bond strengths obtained with each of the three types of adhesives to the essentially unalloyed metals, it appears that the degree of adhesion obtainable to metals does not depend on the densities of the metals. Adhesion was not seriously affected by the atomic arrangement or crystalline structure of these metals. (auth)

**10809** RPL-40/2
Watertown Arsenal. Rodman Lab., Mass.
CURRENT STATUS OF CEMENTED CARBIDE TECHNOLOGY. William O. Woods. June 1958. 37p.

A research program was initiated to determine the current status of cemented carbide technology, including fabrication, properties, and utilization, in order to provide a basis for the selection and classification of these materials for Ordnance application. The historical background, technological development, properties, and applications of cemented carbides are presented. Recommended test methods for the determination of some of the physical properties such as hardness, transverse rupture strength, and density, are included in the appendix. (auth)

**10810** S and T-Memo-20/58
Nottingham Univ., England.
THE EFFECTS OF MEAN STRESS AND OF PRELOADING ON THE FATIGUE LIFE OF A HIGH TENSILE STRUCTURAL STEEL (DUCOL W.25). PART I. F. H. Hooke. Sept. 1958. 44p. Project Report No. 3. Contract 7/Met/997. (C.D./4).

The effects of mean stress and of preloading on the fatigue life of high tensile notched steel (Ducol W.25) were studied. The fatigue tests were carried out under reversed nominal stresses of 28 and 22 tsi with average endurances of 60,000 and 200,000 cycles, respectively. Tensile preloads up to 32 tsi produced no significant effect upon the fatigue life. Preloads of more than this value were found to reduce the fatigue life, the reduction being a function of the amount by which the load exceeded 32 tsi and the time the loads were applied. No improvements in fatigue life were found with zero mean stress. (C.J.G.)

**10811** TID-5382
Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.
EFFECT OF HOT PRESS CLADDING ON MECHANICAL PROPERTIES AND MICROSTRUCTURE OF URANIUM PLATE. W. R. McDonell. Dec. 30, 1954. Decl. Feb. 16, 1960. 8p. Contract [AT(07-2)-1]. OTS.

Hot-press cladding did not significantly change the mechanical properties or microstructure of beta-treated or as-rolled metal. The principal effect of cold rolling the beta-treated plate to a 5% reduction in cross-sectional area was an increase in yield strength (from 40,000 to 60,000 psi) with a corresponding decrease in ductility. Hot-press cladding largely annealed out these effects. The hot-press cladding induced partial recrystallization of the 5% cold-rolled metal. The recrystallization resulted in grains of reduced size in the case of the beta-treated, cold-rolled metal, and of increased size in the case of the as-rolled, cold-rolled metal. Deformation twins caused by cold rolling were annealed out by the hot-pressing operation. (auth)

**10812** TID-5626
Denver. Univ. Denver Research Inst.
STUDY OF FACTORS INFLUENCING DUCTILITY OF IRON–ALUMINUM ALLOYS. Letter Report No. 11. Frank C. Perkins and Joseph F. Nachman. Mar. 7, 1960. 7p. Contract AT(11-1)-742. OTS.

The effect of variations of Al content, heat treatment, and other metallurgical factors upon the room-temperature ductility of Fe–Al alloys is reported. (W.L.H.)

**10813** WADC-TR-59-349
Martin Co., Baltimore.
DEVELOPMENT AND EVALUATION OF STRUCTURAL BERYLLIUM. Final Report for Period May 1, 1958 to April 30, 1959. C. J. Giemza. Apr. 30, 1959. 69p. Project No. 1368. Contract AF33(616)-5180. OTS.

Beryllium fabricated by a hot-upsetting process, a forging process that produces a crystallographic orientation intermediate to the isotropic hot-pressed Be and the anisotropic highly worked Be forms, was found structurally superior to Be sheet produced by current processes. The crystallographic texture necessary to endow Be with the mechanical qualities essential for airframe applications was identified. The mechanical properties of Be were evaluated by tension, compression, and creep tests at room and elevated temperatures. The structural properties of Be were evaluated by construction of a box-beam, fabricated from the hot-upset process sheets, which was subjected to static, dynamic, and creep tests. (C.J.G.)

**10814** AEC-tr-3996
YTTRIUM AND ITS ALLOYS. E. (Ye.) M. Savitskii (Savitskiy) and V. F. Terekhova. Translated from Tsvetnye Metal. 32, No. 1, 48-53(1959). 13p. JCL or LC.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, as abstract No. 21233.

**10815** AEC-tr-4012
THE INFLUENCE OF THERMAL CYCLING ON URANIUM BICRYSTALS. S. Ya. Zalivadnii (Zalivadnij) and V. M. Mikhailovskii (Mikhailovskij). Translated by S. J. Rothman (Argonne National Lab.) from Fiz. Metal. i Metalloved. 8, 904-7(1959). 8p. JCL or LC.

Thermal cycling of uranium bicrystals in the temperature range 100 to 600°C leads to changes inside the grains and along the boundary between them. These changes are of different types and include unilateral creep of the crystallites. The relative movement of the grains per cycle is of the order of $10^{-5}$ in order of magnitude agreement with deformations in coarse-grained polycrystals subjected to similar conditions. (auth)

**10816** UCRL-Trans-475(L)
ON THE THIRD PERIOD OF RELAXATION OF STRESS IN METALS. V. Z. Tseitlin (Zeitlin). Translated by Georgia Ratkay from Zavodskaya Lab. 22, 845-9(1956). 11p. JCL or LC.

Information on the process of relaxation of stress in steels and alloys by Ginzberg (Zavodskaya Laboratoriya 19, 4(1953)) is analyzed. Shortcomings of Ginzberg's work are noted, and it is pointed out that the assertion concerning the presence of the third period of relaxation in metals, characterized by an increase in the creep rate, is not in accordance with reality and can only confuse designers and metallurgists. Data are presented to establish that if a third period appears, it is characterized by a drop in relaxation rate. (J.R.D.)

**10817** UCRL-Trans-502(L)
CHANGE OF RESISTANCE OF ALUMINUM SINGLE CRYSTALS IN STRONG MAGNETIC FIELDS AT LOW

TEMPERATURES. E. Justi and H. Scheffers. Translated by George Condas from Physik. Z. 39, 105-9(1938). 15p. JCL.

The electrical resistance of pure Al single crystals in transverse magnetic fields up to 35 kilogauss and at temperatures 78, 64, 20, and 4.3°K is given. Only a very small anisotropy was found. Below 20°K the resistance increase increases with magnetic field strength but is delayed. A longitudinal effect appears at 20°K amounting to less than $^1\!/_3$ of the corresponding R increase in the transverse field. At constant field (18.7 kilogauss) R reaches a maximum at 40°K. (T.R.H.)

**10818**

THE CRITICAL CONSTANTS OF THE ELEMENTS. David S. Gates and George Thodos (Northwestern Univ., Evanston, Ill.). A.I.Ch.E. Journal 6, 50-4(1960) Mar.

Critical temperatures and pressures for thirty-six elements included in the periodic table from lithium to uranium were predicted from normal boiling points and from previously published vapor-pressure data, respectively. These critical constants were used to calculate both van der Waals' constants. These constants, when plotted against their atomic numbers, produce correlations that may permit the further prediction of van der Waals' constants for other elements. A simple relationship between the critical volume and the volume van der Waals' constant was found to exist and is presented as a basis for predicting the critical volume of elements. (auth)

**10819**

AUTOMATIC SINGLE CRYSTAL DIFFRACTOMETRY. I. THE KINEMATIC PROBLEM. J. Ladell and K. Lowitzsch (Philips Labs., Irvington-on-Hudson, N. Y.). Acta Cryst. 13, 205-15(1960) Mar. 10.

Counter and crystal motions are coupled to explore the reflection space of a crystal along parallel lines in the reciprocal lattice by utilizing any one of three mechanical linkage mechanisms (counter drive linkage, crystal drive mechanism, and point drive mechanism) which are described. The kinematic relations among the moving elements of each of the mechanisms are derived. These relations are used to evaluate the feasibility of these mechanisms as bases for automatic diffractometers. (auth)

**10820**

THE STRUCTURE OF THE INTERMETALLIC PHASE $\theta$(Cr−Al). M. J. Cooper (Cavendish Lab., Cambridge, Eng.). Acta Cryst. 13, 257-63(1960) Mar. 10.

The monoclinic $\theta$-phase in the chromium-aluminum system was shown to be isomorphous with $\alpha'$(V−Al). The structure was refined and the interatomic distances are discussed and compared with those in $\alpha'$(V−Al) and with those in two ternary alloy phases containing chromium and aluminum. (auth)

**10821**

THE POLARIZATION CORRECTION FOR UPPER LEVEL GEOMETRY USING CRYSTAL MONOCHROMATIZED RADIATION. H. A. Levy and R. D. Ellison (Oak Ridge National Lab., Tenn.). Acta Cryst. 13, 270-1(1960) Mar. 10.

An evaluation of the polarization correction factor P and its angular representation $\rho$ was made relative to the orientation of the instrumental polar axis with respect to the plane of incidence at the monochromator. (C.J.G.)

**10822**

THE PROBABLE ISOMORPHISM OF PLUTONIUM(IV) AND THORIUM(IV) ACETYLACETONATES. Alan E. Comyns (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Acta Cryst. 13, 278(1960) Mar. 10.

It is suggested, from a review of published literature, that plutonium acetylacetonate crystals are isomorphous with the $\beta$-forms of zirconium and thorium acetylacetonates. (C.J.G.)

**10823**

Cr−Mo−V LOW-ALLOY STEELS FOR SERVICE AT ELEVATED TEMPERATURES. Alloy Metals Rev. 8, No. 94, 1-8(1959) Dec.

A review is given of the properties of Cr−Mo, Cr−V, and Cr−Mo−V steels for service at elevated temperatures. (C.J.G.)

**10824**

CRYSTALLOGRAPHIC DATA: ZIRCONIUM CARBIDE. Charles P. Kempter and R. Jay Fries (Los Alamos Scientific Lab., N. Mex.). Anal. Chem. 32, 570(1960) Apr.

X-ray-powder-diffraction data are presented for ZrC with Miller indices assigned to approximate interplanar spacings. A lattice constant of 4.698 A is given for hafnium-free ZrC. For stoichiometric ZrC, the Zr-C bond distance for coordination number 6 is reported as 2.394 A and the theoretical density as 6.56 g per cc at 25°C. (C.J.G.)

**10825**

THE MELTING POINT DETERMINATION OF BINARY MIXTURES OF URANIUM OXIDE WITH SOME OTHER OXIDES IN THE AIR. S. G. Tresvyatskii and V. I. Kushakovskii. Atomnaya Energ. 8, 56-8(1960) Jan. (In Russian)

The melting points of uranium oxide in binary mixtures with $Al_2O_3$, $BaCO_3$, BeO, $Bi_2O_3$, $CaCO_3$, $CeO_2$, $Cr_2O_3$, $Fe_2O_3$, $H_3PO_4$, $H_2WO_4$, $La_2O_3$, MgO, $MnCO_3$, $(NH_4)_2MoO$, $SiO_2$, $Ta_2O_5$, $ThO_2$, $TiO_2$, $V_2O_5$, and $ZrO_2$ were determined. Results are tabulated. (R.V.J.)

**10826**

DISTRIBUTION OF Fe IN MICROVOLUME OF ZIRCONIUM ALLOYS. P. L. Grusin, G. G. Ryabova, and G. B. Fedorov. Atomnaya Energ. 8, 58-9(1960) Jan. (In Russian)

The distribution of Fe in Zr alloy with 0.15 wt. % Fe and in Zircaloy with 1.1 wt. % Sn, 0.1 wt. % Fe, 0.1 wt. % Cr, and 0.05 wt. % Ni was studied by contact autoradiography. The radiation intensities of the specimens were 5000 to 10,000 pulse/min cm$^2$. After various thermal treatments the distribution of iron remained irregular. In cast alloys most of the iron was found at the boundaries of the $\alpha-\beta$ phase transformation; after 5 to 10% cold deformation the picture remained unaltered. Annealing Zr with Fe at 600°C for 20 hours and at 500°C for 40 hours after quenching at 1200 and 900°C produced no change in the irregular distribution. The process of iron redistribution in Zircaloy was slower due to the presence of Cr and Ni. (R.V.J.)

**10827**

CERAMICS FOR REACTOR MATERIALS. Joseph Koretzky and William C. Riley (Battelle Memorial Inst., Columbus, Ohio). Battelle Tech. Rev. 8, 8p.(1960) Feb.

The properties and uses of ceramics in reactor moderators, reflectors, fuel elements, control devices, and shields are discussed. (C.J.G.)

**10828**

NON-METALLIC DISPERSIONS IN COBALT AND ITS ALLOYS. PART ONE. DISPERSIONS IN PURE COBALT. Rudolf Palme (Battelle Memorial Inst., Frankfurt am Main). Cobalt No. 6, 15-22(1960) Mar.

An investigation is presented of the effects of non-metallic dispersants in cobalt and its alloys. An investigation was first conducted on the properties of sintered cobalt powders, then the dispersants were added to the sintered powders as oxides or carbides. The oxide additions impede slipping phenomena in the crystals, which explains their influence on the yield strength of the material; but the grain boundary strength is hardly affected. The carbides segregate at the grain boundaries and tend to increase strength. Boride and nitride dispersions display this same characteristic. (B.O.G.)

**10829**

DIRECT OBSERVATION OF DISLOCATIONS IN FRITTED URANIUM DIOXIDE. Alexandre Portnoff and Roger Caillat (Centre d'Études Nucléaires, Saclay, France). Compt. rend. 250, 1653-5(1960) Feb. 29. (In French)

Electrolytic polishing permits a detailed study of the microstructure of fritted uranium oxide pellets. By this technique it was possible to detect with an optical microscope the arrangements of dislocations. (tr-auth)

**10830**

ROTAMETERS IN CORROSION SERVICE. Ind. Eng. Chem. 52, No. 3, 61A-2A(1960) Mar.

The properties of various materials for use in the construction of rotameters which are to be employed in corrosive environments are discussed. The materials discussed include stainless steel, nickel alloys, hard lead, synthetic resins, polymers, elastomers, and glass. (C.J.G.)

**10831**

OXIDATION OF METALS. CHEMICAL ENGINEERING FUNDAMENTALS REVIEW. W. W. Smeltzer (McMasters Univ., Hamilton, Ont.). Ind. Eng. Chem. 52, 271-6(1960) Mar.

A review of developments in studies of metal oxidation is presented relative to the theory, properties, and structures of oxides, oxidation reactions, and alloy oxidation reactions. (C.J.G.)

**10832**

CREEP OF $Al_2O_3$ SINGLE CRYSTALS. Roger Chang (Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.). J. Appl. Phys. 31, 484-7 (1960) Mar.

The "steady-state" creep of $Al_2O_3$ single crystals was investigated. The experimental data are analyzed according to three mechanisms: the dislocation climb mechanism, the micro-creep mechanism, and the Peierls stress mechanism. It is shown that the dislocation climb mechanism fits experimental data best. The expectation that Peierls stress mechanism is rate controlling in the "steady-state" creep of $Al_2O_3$ is ungrounded. (auth)

**10833**

LOW-TEMPERATURE TRANSPORT PROPERTIES OF COMMERCIAL METALS AND ALLOYS. II. ALUMINUMS. Robert L. Powell, William J. Hall, and Hans M. Roder (National Bureau of Standards, Boulder, Colo.). J. Appl. Phys. 31, 496-503(1960) Mar.

The thermal conductivity, electrical resistivity, Lorenz number, thermoelectric force, and thermoelectric power are given in the temperature range 4 to 120°K for ten aluminums and aluminum alloys: high-purity, 1100-F, 1100-O, 3003-F, 2024-T4, 5052-O, 5083-O, 5086-F, 5154-O, and 6063-T5. Four of the samples show a maximum in thermal conductivity, the others do not. For the four high-thermal conductivity samples the separate components in the electronic thermal resistivity are resolved; for the others, components in both the electronic and the lattice thermal resistivities are given. The residual electrical resistivities vary from $2.5 \times 10^{-8}$ to $3.2 \times 10^{-6}$ ohm cm. The Lorenz numbers for the high-conductivity samples fall considerably below the Sommerfeld value $2.44 \times 10^{-8}$ watt-ohm/°$K^2$; those for the low-conductivity samples are somewhat above the Sommerfeld value. The thermoelectric power of some of the alloys is positive with respect to the high-purity sample, for others it is negative. The various properties, methods of analysis, and separation of components are discussed in detail. (auth)

**10834**

LOW-TEMPERATURE TRANSPORT PROPERTIES OF COMMERCIAL METALS AND ALLOYS. III. GOLD-COBALT. Robert L. Powell, M. D. Bunch, and Edward F. Gibson (National Bureau of Standards, Boulder, Colo.). J. Appl. Phys. 31, 504-5(1960) Mar.

The thermal conductivity, electrical resistivity, and Lorenz number are given in the temperature range 4 to 100°K for the widely used thermocouple wire, gold-2.1 at. % cobalt alloy. The total thermal conductivity is relatively low: from 0.01 watt/cm°K at 4°K to 0.23 at 100°K. The lattice contribution to the total thermal conductivity is larger than the electronic contribution. The electrical resistivity is nearly independent of temperature, but does have a definite minimum of about $1.20 \times 10^{-5}$ ohm-cm at 30°K. Because of the relatively large contribution of the lattice term to the total thermal conductivity, the Lorenz number is considerably above the electronic Sommerfeld value, $2.44 \times 10^{-8}$ watt-ohm/°$K_2$. (auth)

**10835**

ON THE BEHAVIOR OF THERMAL VACANCIES IN PURE ALUMINUM. Doris Kuhlmann-Wilsdorf (Univ. of Pennsylvania, Philadelphia) and H. G. F. Wilsdorf (Franklin Inst., Philadelphia). J. Appl. Phys. 31, 516-25(1960) Mar.

The results are reported of an investigation of quenched-in prismatic dislocation loops in super-purity aluminum. Some new effects were observed: in particular, that loops tend to be grouped in clusters containing a surplus of loops of one orientation; that more than four loop orientations are realized; and that often pairs of similarly oriented and similarly shaped loops are present in the quenched material. It is concluded that vacancies aggregate into three dimensional clusters, containing from a few to a few hundred or even thousand vacancies, before being converted into prismatic loops. (auth)

**10836**

GRAIN BOUNDARIES IN GERMANIUM. Richard S. Wagner and Bruce Chalmers (Harvard Univ., Cambridge, Mass.). J. Appl. Phys. 31, 581-7(1960) Mar.

The relative energies and the boundary orientations of simple tilt boundaries in germanium crystals were measured. The measurements were made on columnar tricrystals prepared by the modified Czochralski method. The orientations of the columnar tricrystals were either (100) and (111) isoaxial or (100) isoplanar. The relative grain boundary energies were measured as a function of the angular misorientation $\theta$ between two grains. The crystallographic orientations of the grain boundary plane were also determined. It was found that the relative energy of (100) and (111) tilt boundaries up to about 15° of misorientation changes with misorientation as predicted by Read and Shockley's theory. For larger angles of misorientation, the grain boundary energy is essentially independent of the angle of misorientation. This indicates a significant but continuous change in boundary structure at the transition region. Additional evidence for the difference in the structure of low- and high-angle tilt boundaries was found in the apparent strong dependence of the energy of low-angle boundaries on the boundary orientation. Low-angle (100) twist boundaries were not observed. (auth)

**10837**

GRAIN BOUNDARY AND LATTICE DIFFUSION IN POLYCRYSTALLINE BODIES. H. S. Levine and C. J. MacCallum (Sandia Corp., Albuquerque, N. Mex.). J. Appl. Phys. 31, 595-9(1960) Mar.

Diffusion in a polycrystalline body is discussed under the assumption that two interrelated mechanisms consisting of diffusion through the grains and in the boundaries around the grains are dominant in different penetration regions. The general behavior of the average concentration-distribution of diffusant is described for the separate action of each mechanism, and the effects of their combined action are inferred. A realistic diffusion model for a polycrystalline body and a suitable empirical function to describe the loss of diffusant from the boundaries to the grains form the basis for these computations. Results are specifically applied to the analysis of the usual sectioning technique for measuring the ratio of grain boundary to lattice diffusion constants in a polycrystalline body. It is shown that, in the penetration range most commonly covered in polycrystalline diffusion experiments, the log of the average concentration varies as the 6/5 power of penetration depth contrary to the linear law reported previously. Comparison is made between the present and previous methods for establishing the grain boundary diffusivity of silver. The results are found to differ by a factor of 3 or 4. Criteria for validity of the method associated with the relative magnitudes of reduced time, grain size, and the ratio of grain boundary to lattice diffusion constants are established. Some of the results reported for Zn and Cd do not satisfy these criteria. (auth)

**10838**

CLEAVAGE FRACTURE IN NIOBIUM. A. T. Churchman (Associated Electrical Industries, Ltd., Aldermaston, Berks, Eng.). J. Inst. Metals 88, 221-2(1960) Jan.

Niobium with a sufficiently high interstitial impurity content and a coarse grain size has a ductile ⇌ brittle transition temperature. In the brittle range, cleavage occurs on both (1 0 0) and (1 1 0) planes. (auth)

**10839**

THE INFRARED SPECTRUM AND POTENTIAL FUNCTION OF NITROSYL CHLORIDE. L. Landau (Oak Ridge National Lab., Tenn.) and W. H. Fletcher (Univ. of Tenn., Knoxville). J. Mol. Spectroscopy 4, 276-83(1960) Mar.

The infrared spectra of $ClN^{15}O$ and $ClN^{14}O$ were examined with a prism spectrometer. The data obtained are sufficient to yield all of the anharmonic constants, $X_{ij}$, and the harmonic frequencies. The potential field was found to be adequately described by using a van der Waals repulsion term between the chlorine and oxygen atoms, or by assuming that the only interaction is one due to change in orbital hybridization, which couples the bending with the N—Cl stretch. For the first case the force constants are: $K_{NO} = 14.12$, $K_{NCl} = 1.70$ millidynes/A and $K_{\gamma} = 0.827 \times 10^{-11}$ ergs/radian$^2$. The van der Waals constant $A = 0.014$ millidynes/A. For the second case the principal constants are only slightly different. (auth)

**10840**

THE FORMATION OF INTERMEDIATE ALLOY LAYERS IN THE INTER-DIFFUSION OF METALS. J. D. Baird (A.E.I. Research Lab., Aldermaston, Berks, Eng.). J. Nuclear Energy, Pt. A, Reactor Sci. 11, 81-8(1960) Feb. (In English)

Usually all equilibrium phases are formed in a diffusion couple of two metals, but the conditions where this may not occur are discussed. Once nucleated, a phase layer should grow parabolically if growth is controlled by volume diffusion through the layer. If grain boundary diffusion predominates at low temperatures the index n in the growth equation $x = kt^{1/n}$ may lie between 2 and 4. Where oxide films are present between the metals or transfer across phase interfaces is rate-controlling, $1 < n < 2$ in the early stages of diffusion but later n should rise to between 2 and 4. The factors controlling the value of the growth constant k are discussed and the importance of activity gradients in the phase is emphasized. Experimental observations on the important effect of pressure on growth rates are reviewed critically. (auth)

**10841**

LOW-TEMPERATURE MAGNETIC REMANENCE, MOLECULAR FIELD, AND APPROACH TO SATURATION OF HOLMIUM METAL. Warren E. Henry (U. S. Naval Research Lab., Washington, D. C.). Phys. Rev. 117, 89-92 (1960) Jan. 1.

Magnetization approaching absolute magnetic saturation was achieved for polycrystalline holmium metal. At 1.3°K and 70,000 gauss, the magnetic moment is approaching 4.0 Bohr magnetons per atom of holmium in contrast to the 10 Bohr magnetons per atom expected on the basis of the spectroscopically determined quantum numbers. The actual results are explained on the basis of crystalline electric field splitting of the ground term of holmium and application of the Pauli exclusion principle. In the liquid helium range, there is a pronounced hysteresis; i.e., the moment at 10,000 gauss is 50% higher in decreasing fields than in increasing fields. The remanence is 0.22 Bohr magneton per atom of holmium at 4.2°K and 0.42 Bohr magneton per atom at 1.3°K. A sample motion technique was used to measure the magnetic moment of the 5-gram sample. The equipment was calibrated with iron and nickel. (auth)

**10842**

TEMPERATURE DEPENDENCE OF THE MAGNETIZATION OF DYSPROSIUM METAL. Kazuo Niira (Iowa State Univ. of Science and Tech., Ames). Phys. Rev. 117, 129-33 (1960) Jan. 1.

The experimental fact that the temperature dependence of the saturation magnetic moment of dysprosium metal shows a marked departure from the Bloch $T^{3/2}$ law at low temperatures is interpreted as due to magnetic anisotropy. The calculation is in the spin-wave approximation and gives a result which agrees well with the observed temperature dependence of the magnetization if the magnitude of the magnetic anisotropy is suitably chosen. A discussion on the atomic origin of the magnetic anisotropy is given. (auth)

**10843**

ELECTROCONDUCTIVITY OF MOLTEN SALT SOLUTIONS. I. THE SYSTEM $PbCl_2$—KCl. M. F. Lantratov and O. F. Moiseeva [(V. I. Ul'ianov (Lenin) Electrotechnical Inst. of Leningrad)]. Zhur. Fiz. Khim. 34, 367-74(1960) Feb. (In Russian)

The electroconductivity of molten $PbCl_2$—KCl solutions was measured over the range of 0 to 1.0 molar fractions of potassium chloride. The specific electroconductivity curve of $PbCl_2$ has a point of inflexion at 600 to 650°C due to change in structure of molten lead chloride with temperature. The specific and equivalent electroconductivity isotherms exhibit a deep minimum at the composition $N_{KCl} =$ 0.6 to 0.7, the minimum becoming sharper with decrease in the temperature. The equivalent electroconductivity isotherms possess a small depression maximum at $N_{KCl} = 0.1$, the formation of which is explained by dissociation of the autocomplexes $(PbPbCl_4)_n$ on addition of small amounts of KCl. The negative deviations of electroconductivity found their explanation in the presence of complex lead ions in the melt. (auth)

**10844**
IMPROVEMENTS RELATING TO ZIRCONIUM ALLOYS. Thomas Raine and James Alan Robinson (to Metropolitan-Vickers Electrical Co., Ltd.). British Patent 829,668. Mar. 2, 1960.

A Zr alloy for use in $CO_2$ at up to 600°C is described. Two preferred compositions are given: 0.5% Cu, 0.5% Mo, Zr; and 1.0% Cu, 1.5% Mo, Zr. Hardness, tensile, and corrosion data are given to compare these compositions with Zr and Zircaloy-2. Heat treatment at 850 to 950°C followed by quenching further improves the high-temperature mechanical properties. (T.R.H.)

## Radiation Effects

**10845** AECU-4733
Engelhard Industries, Inc., Newark, N. J.
EFFECT OF IRRADIATION OF SOLID CATALYSTS. Quarterly Progress Report No. 3. H. C. Andersen, P. N. Rylander, and Carl D. Keith. Feb. 25, 1960. 27p. Contract AT(30-1)-2402. OTS.

Irradiation of catalyst samples composed of ruthenium or palladium at 200 megarads of beta radiation is reported. Gas reactions such as O + H, CO + O, and nitrous oxide decomposition were used for testing the activity of these catalysts. Evaluation data are included. Liquid phase hydrogenations were done using benzene, phenol, propionitrile, pyridine, and chlorobenzene. Results of experiments in which irradiated and non-irradiated catalysts were used are given. The effect of irradiation appears negligible for most catalysts. Preparation and properties of NiO and ZnO were studied, and carriers were prepared using the NiO and ZnO for platinum and palladium. These samples are scheduled for beta irradiation. (J.R.D.)

**10846** BMI-1419
Battelle Memorial Inst., Columbus, Ohio.
HIGH-TEMPERATURE IRRADIATION OF METALS AND GRAPHITE IN FLOWING HELIUM. Neil E. Miller, Donald J. Hamman, Ward S. Diethorn, and William H. Goldthwaite. Feb. 23, 1960. 18p. Contract W-7405-eng-92. OTS.

As part of the coolant-core evaluation studies in an early phase of the Maritime Gas-Cooled Reactor program, nickel, K-Monel, niobium-1 wt.% zirconium, and graphite were irradiated in a convective flow of helium. A capsule of novel design was used to study the corrosion of the metals at 1500 and 960°F in a 243-hr BRR experiment. Four helium-filled quartz tori, containing the specimens, were encapsulated in a stainless steel capsule. A convective flow of helium was maintained in the closed tori by heating one leg of each torus to 1500 and the other at 960°F. Zirconium foil was placed in two of the tori to getter gaseous impurities. No attack of the nickel and niobium-1 wt.% zirconium was observed at either temperature. Metallographic examination did show a 1 to 2.5-mil attack of the K-Monel at 1500°F in a torus containing no getter. (auth)

**10847** NAA-SR-4641
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
EVALUATION OF IRRADIATED OMRE FUEL ELEMENTS FIRST CORE LOADING. J. H. Walter, J. F. Leirich, and G. D. Calkins. Mar. 1, 1960. 58p. Contract AT-11-1-GEN-8. OTS.

Irradiated fuel elements from the OMRE first core loading were examined and evaluated to determine: (1) the stability of the floating plate fuel element design, (2) the stability of the stainless steel clad $UO_2$–stainless steel cermet core fuel plates under irradiation and exposure to the organic coolant, (3) the extent and nature of deposits on the fuel element surfaces, and (4) the distribution of burnup in the fuel elements. An evaluation of the only damaged fuel element from the OMRE first core is presented. Maximum fuel surface temperature for the first core was 750°F. The maximum burnup on the fuel elements examined was 9 at.% U. The two undamaged fuel elements evaluated were in good mechanical and metallurgical condition. Film deposits were observed on the surfaces of the fuel element with the highest exposure. Burnup profiles were established by scanning plates for relative gamma intensity and correlating the scans with radiochemical burnup analyses. The damaged fuel element lost coolant flow due to inadvertent, improper installation in the reactor core. Subsequent overheating resulted in the formation of carbonaceous deposits which deformed the fuel element. (auth)

**10848** NAA-SR-Memo-3657
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
PRODUCTION OF FISSION GAS IN U–10 w/o MOLY FUEL RODS. R. H. Davidson. Apr. 3, 1959. 5p. OTS.

Tests of 2.85% enriched U–10 wt. % Mo rods revealed that the total concentrations of fission gases after exposures of 3000 and 7000 Mwd/t are $3.02 \times 10^{19}$ atoms/cc and $6.78 \times 10^{19}$ atoms/cc, respectively. Isotopic concentrations are tabulated. (J.R.D.)

**10849** NAA-SR-Memo-4782
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
DATA PACKAGE, EXPERIMENT AI-4, $UO_2$ RATCHETING. B. M. Watson. Dec. 22, 1959. 42p. OTS.

Two of a series of experiments initiated to investigate problems of differential thermal expansion and irradiation damage associated with thin stainless steel jacketed $UO_2$ fuel rods are reported. (W.L.H.)

**10850** NP-8391
[Aktiebolaget Atomenergi, Stockholm].
SOME GENERAL REQUIREMENTS FOR IRRADIATION EXPERIMENTS. H. P. Myers and R. Skjöldebrand. [1959]. 10p. (S-10).

For presentation at the EAES-Symposium on Reactor Materials, Saltsjöbaden, Stockholm, October 5–9, 1959.

An outline of the general requirements for irradiation experiments using reactors is presented. The availability of facilities for irradiation experiments within the European Atomic Energy Society countries is examined and limitations of these facilities are discussed. (J.R.D.)

**10851** NP-8436
Dewey and Almy Chemical Co., Cambridge, Mass.
EFFECT OF RADIATION ON THE PHYSICAL PROPERTIES AND THE SEALING OF CANS. Report No. 2 (Final) [for] November 1, 1956 to July 30, 1958. J. H. Brillinger. 3p. Contract QMR&D (Natick) No. 63.

The effects of ionizing radiation (up to 5.6 megarad) on the physical properties of several can sealing compounds are reported. Compounds based on unvulcanized butadiene-styrene rubber, butadiene-acrylonitrile rubber, or natural rubber were cross linked and toughened. Compounds based on neoprene or vulcanized rubber were not noticeably changed. Compounds based on butyl rubber were softened.

No measurable difference in the sealing performance of irradiated and non-irradiated cans nor between cans irradiated by 2 Mev electrons and cans irradiated by gamma rays was detected. (C.J.G.)

**10852** NP-8437
National Salt Co., New York.
DISCOLORATION AND STERILIZATION OF SALT BY RADIATION TREATMENT. Report No. 3 (Final) [for] April 29, 1957—April 28, 1959. Kurt Ladenburg. 9p. Project No. 7-84-01-002. Contract QMRE (Natick) No. 80 (Agreement).

Results indicate that the discoloration of salt produced by irradiation is a solid-state phenomenon due to phase transformation in the sodium chloride crystals when a free electron was trapped in an anion vacancy. (C.H.)

**10853** TID-5597
Brown Univ., Providence. Metals Research Lab. and Brookhaven National Lab., Upton, N. Y.
THE EFFECT OF COBALT 60 GAMMA-RAY IRRADIATION ON ULTRASONIC ATTENUATION AND VELOCITY IN NaCl AND KCl. Andrew V. Granato, Norman G. Einspruch, Louis J. Teutonico, Peter C. Waterman, Bruce B. Chick, Rohn Truell, and Paul W. Levy. Dec. 1959. 38p. Contract AT(30-1)-1772. OTS.

The influence of $\gamma$ rays from a Co$^{60}$ source on the ultrasonic attenuation in NaCl in the 10 to 200 megacycle per second range was studied. The measurements were made on both compressional and shear wave propagation in the [100] direction of both NaCl and other alkali halides. (W.L.H.)

**10854** TID-5641
Columbia Univ., New York.
PROGRESS REPORT ON EQUIPMENT LOAN CONTRACT AT(30-1)-1919, MODS. 1 AND 2. [1959]. 19p. OTS.

The design of a Co$^{60}$ irradiation facility is presented. (W.L.H.)

**10855** TID-5644
Brown Univ., Providence.
RADIATION DAMAGE STUDIES USING THE TECHNIQUES OF ELECTRON-SPIN PARAMAGNETIC RESONANCE. Annual Progress Report [for] May 1, 1959 through April 30, 1960. P. J. Bray and A. O. Williams, Jr. Mar. 1, 1960. 20p. Contract AT(30-1)-2024. OTS.

Work on F-type centers in LiF is near completion. Further investigations of the ESPR of conduction electrons in Li formed in heavily damaged LiF are described. Hyperfine structure was studied in the ESPR spectra of irradiated glasses. Studies of irradiated NaF and azides are also reported. (For preceding period see NYO-8532.) (T.R.H.)

**10856** UCRL-8682
California. Univ., Berkeley. Lawrence Radiation Lab.
CONTROLLED THERMONUCLEAR RESEARCH QUARTERLY REPORT [FOR] DECEMBER 1958, JANUARY AND FEBRUARY 1959. Mar. 11, 1959. Decl. Feb. 15, 1960. 81p. Contract W-7405-eng-48. OTS.

A list of recent talks and publications by laboratory personnel is given. The efforts of the Pyrotron group were, for the most part, concentrated in two major areas. The first of these was directed toward the documentation and improvement of the encouraging results obtained in the magnetic compression, adiabatic heating, and stable confinement of "low temperature" plasmas captured in experimental mirror machines. The other major area of effort was centered around the Felix experiment which is directed toward studying the problems of creating a hot plasma in a mirror machine by the injection and trapping of energetic particles. As part of a general program of plasma physics studies, effort has been going forward to exploit the steady-state plasma source known as P$^4$ in determining various fundamental effects, such as wave propagation and spectrum-line excitation, which can be studied effectively in a device such as this. The Astron program is summarized and work on the E layer is discussed. The design of the first Astron model, including a 5-foot traveling-wave line for the electron injector, was completed and the components ordered. Major experimental objectives of the Livermore Pinch Program at present are to determine the nature of the small-scale turbulence that is interfering with the pinch and to investigate further the mechanism by which the plasma energy is carried to the wall. Two plausible suggestions regarding the nature of the turbulence were made: (a) that it is hydromagnetic and (b) that it is electrostatic in origin. In addition, several special lines of research, not directly related to pinch work, are being pursued. The Berkeley Pinch Program is concerned primarily with the sheet pinch as exemplified by "Triax" and with rotating plasmas created in EXH "homopolar" geometries. A project was recently initiated with the objective of studying the excitation and propagation of plasma oscillations at microwave frequencies and developing plasma diagnostic techniques based upon the understanding of these plasmas. Theoretical research is briefly summarized. Design values, status of work, and development of components for the various programs are given. (W.D.M.)

**10857**
COLOUR AND TRANSPARENCY CHANGES IN GLASSES UNDER ACTION OF Co$^{60}$ AND NUCLEAR REACTOR RADIATION. S. M. Brekhovskikh. Atomnaya Energ. 8, 37-43(1960) Jan. (In Russian)

Nineteen glasses of various oxide compositions were irradiated with $10^6$ r from a Co$^{60}$ source and $5 \times 10^{10}$ r in a reactor. The specimens, 30 mm in diam. and 5 mm in thickness, were analyzed with a quartz spectrophotometer (SF-$\mu$) and a tri-colored colorimeter (VEI). Their stability, saturation, minimum transparency, and darkening are tabulated, and means for improving radiation resistance are suggested. (R.V.J.)

**10858**
INFLUENCE OF IRRADIATION WITH $\beta$ RAYS ON THE ELECTRIFICATION OF KCl CRYSTALS. Anna Szaynok (Inst. of Tech., Wrocław, Poland). J. Appl. Phys. 31, 451-3(1960) Mar.

The measurements of electrical charges on dust clouds of crushed KCl monocrystals previously irradiated with $\beta$ rays shows that the value of the mean charge depends on irradiation time. In the case of KCl irradiated with $\beta$ rays, a photoelectric effect is not observed, despite the presence of F centers. (auth)

**10859**
EFFECT OF FAST NEUTRON BOMBARDMENT AT VARIOUS TEMPERATURES UPON THE YOUNG'S MODULUS AND INTERNAL FRICTION OF COPPER. D. O. Thompson and V. K. Paré (Oak Ridge National Lab., Tenn.). J. Appl. Phys. 31, 528-35(1960) Mar.

Studies were made of the variations of internal friction and elastic modulus during irradiation of pure copper crystals at a number of temperatures in the range 90 to 300°K. The results are interpreted in terms of pinning of dislocation lines by radiation defects migrating from their points of origin. In terms of the room temperature value the dislocation pinning rate is $2.5 \times 10^{-2}$ in the range 100 to 140°K and (from previous measurements) of the order of $2.5 \times 10^{-5}$ at 20°K. On slowly warming the sample after the irradiation, it is found that at 260°K the modulus and decrement begin to move rapidly toward their "saturation" values. Presumably, defects "stored" in the sample due to a lack of thermal mobility at the irradiation temperature become mobile at this temperature and move to the dislocation lines. (auth)

**10860**
EVIDENCE FOR DISLOCATION REACTIONS IN COPPER. F. W. Young, Jr. and T. S. Noggle (Oak Ridge National Lab., Tenn.). J. Appl. Phys. 31, 604-6(1960) Mar.

Observations of slip lines and etch pits at dislocations on a copper crystal hardened by irradiation and deformed by bending are interpreted in terms of dislocation reactions. (auth)

**10861**
RADIATION LIMITED DISLOCATION MOTION IN CRYSTALS. Robb Thomson (Univ. of Illinois, Urbana). J. Appl. Phys. 31, 617(1960) Mar.

The thermal activation of dislocations across the Peierls energy barriers is discussed. It was previously suggested that a large Peierls energy does not necessarily inhibit the dynamic motion of a dislocation if it lies slightly skew to a symmetric crystallographic direction. In investigations of crystals with large Peierls energy, the observed critical sheer stress where the dislocations become mobile cannot be due to a dynamic motion of the dislocation, but the dislocations must be thermally activated through the lattice hill-valley structure similar to that of Lothe and Hirth. (B.O.G.)

**10862**
SOME PROPERTIES OF X-RAY DAMAGED ROCHELLE SALT. Kenkichi Okada (Aichi Gakugei Univ., Nagoya, Japan). J. Phys. Soc. Japan 15, 363-4(1960) Feb. (In English)

The results of an investigation of x-ray damaged rochelle salts are presented. The changes in the ferroelectric hysteresis loops of the radiation-damaged crystals were studied. The effects of biasing the d-c field on the Curie points of an x-ray damaged rochelle salt was compared to that of a virgin rochelle salt. (B.O.G.)

**10863**
RADIATION DAMAGE IN IRON AND STEEL. D. R. Harries (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Power 5, No. 47, 97-9(1960) Mar.

The effects of neutron irradiation on the tensile properties of pure iron, ferritic steels, and austenitic steels were studied. Irradiation effects on the above materials were similar, i.e., increase in yield and ultimate tensile strengths and reduction in elongation to fracture and reduction of area values. (C.J.G.)

**10864**
F-CENTER GROWTH CURVES. P. V. Mitchell, D. A. Wiegand, and R. Smoluchowski (Carnegie Inst. of Tech. Pittsburgh). Phys. Rev. 117, 442-3(1960) Jan. 15.

It is shown that the increase in the density of F centers in KCl due to x-ray irradiation can be described kinetically by considering two independent groups of negative ion vacancies. One group is composed of vacancies in the lattice before irradiation, while the other is composed of vacancies generated during the irradiation. It is concluded from the difference in the electron capture cross sections for the two groups of vacancies and the intensity dependence of the rate of generation of new vacancies that the vacancies are generated at dislocations by a multiple ionization process. (auth)

# PHYSICS

## General and Miscellaneous

**10865** AERE-M-522
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
A NOTE ON THE PRODUCTION OF A SPECIFIED MAGNETIC FIELD BY A CYLINDRICAL COIL CONFIGURATION OF VARIABLE DEPTH. E. W. Laing and S. J. Roberts. Nov. 1959. 18p. BIS.

A method is described for the determination of a cylindrical coil configuration of variable depth which will produce any specified magnetic field on the axis of the cylinder with a high degree of accuracy. Programs were written for the Mercury computer which calculate the coil depths, and the magnetic field both on and off the axis of the cylinder. (auth)

**10866** AERE-M-599
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE PERMEABILITY OF SOME PLASTIC MATERIALS TO $H_2$, He, $N_2$, $O_2$, AND A. R. S. Barton. Feb. 1960. 8p. BIS.

**10867** AFOSR-TN-60-71
Stanford Research Inst., Menlo Park, Calif.
COMPUTATION OF WHISTLER RAY PATHS. Final Letter Report—Part II. Irving Yabroff. Dec. 1959. 51p. SRI Project 2241. For Stanford Univ. Contract AF18(603)-126.

An attempt is made to demonstrate some complex phenomena of "magneto-ionic duct" propagation. Computations in a preliminary state are offered without interpretation. (T.R.H.)

**10868** AFOSR-TN-60-138
Stanford Research Inst., Menlo Park, Calif.
THE THEORY OF PROPAGATION OF RAYS IN AN INHOMOGENEOUS AND ANISOTROPIC MEDIUM. Final Letter Report—Part I. J. J. Brandstatter. Dec. 1959. 65p. SRI Project 2241. For Stanford Univ. Contract AF18(603)-126.

A theory of ray propagation in inhomogeneous anisotropic media is presented. The Haselgrove normalization of the Hamiltonian is adopted, and Synge's group velocity concept is carried over. The theory is generalized to include absorption and a method of giving a measure of the dispersion of the rays based on the notion of geodesic deviation. The derivation is given in detail of the ray-path equations for a general curvilinear coordinate system. The exposition is useful in calculating ionospheric ray paths in a form suitable for integration by standard numerical methods such as the Runge-Kutta method and is also useful in ray tracing in plasmas less weakly ionized than the ionosphere. (T.R.H.)

**10869** BMI-1422
Battelle Memorial Inst., Columbus, Ohio.
NUMERICAL SOLUTION OF FUEL-ELEMENT THERMAL-STRESS PROBLEMS. Robert F. Redmond, Harry Pollack, Alton E. Klickman, William S. Hogan, Harold M. Epstein, and Joel W. Chastain. Feb. 26, 1960. 48p. Contract W-7405-eng-92. OTS.

In developing a method of numerical analysis for the solution of thermal-stress problems special emphasis was given to fuel elements with internal coolant channels. Numerical techniques for reducing the partial differential equation system to a form suitable for numerical solution and a new iterative method of solving large systems of linear algebraic equations were employed. Computer codes were devised to obtain the numerical solution of the thermal-stress problems and were used to obtain numerical results for single-hole and seven-hole hexagonal elements and plate-type elements. Comparisons were made between analytical results and numerical results for the case of the simple annulus shape. (auth)

**10870** GAT-DM-821
Goodyear Atomic Corp., Portsmouth, Ohio.
LIKELIHOOD RATIO TEST. D. L. Thomas. Mar. 9, 1960. 6p. OTS.

An IBM-650 computer program written to make the necessary calculations for the Likelihood Ratio Test is presented. The calculations are designed to help determine when all the systematic error components have been removed from lattice parameter measurements. Input data are given along with operating instructions. (J.R.D.)

**10871** HASL-64
New York Operations Office. Health and Safety Lab., AEC.
A SYSTEM FOR THE AUTOMATIC COMPUTATION OF DISINTEGRATION RATES FROM RADIOCHEMICAL DATA. William R. Collins, Jr. May 27, 1959. 51p. OTS.

A system is presented for the use of an automatic computer for the calculation of disintegration rates of radionuclides from radiochemical data. A general mathematical expression is derived for nuclides determined by a single measurement on the sample. Additional equations are obtained for the analysis of nuclide pairs by the subtraction of the counting rate of one nuclide from that of the combined nuclides. Automatic computation of these general formulas from raw data and procedures for their adaptation to a number of specific analyses are described. (auth)

**10872** HW-62727
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
NUCLEAR PHYSICS RESEARCH QUARTERLY REPORT FOR JULY, AUGUST, SEPTEMBER 1959. Oct. 20, 1959. 66p. Contract AT(45-1)-1350. OTS.

Theoretical Reactor Physics: Recent work in a continuing study of the position and energy dependence of the neutron flux in a heterogeneous system is described. The case of an infinite cylinder is considered, with the absorption cross section varying as 1/v, surrounded by a homogeneous, source-free, non-absorbing heavy gas medium. The effect of the absorber on the neutron flux in the surrounding medium is sought. A steady state is assumed, the neutrons removed by the absorber being replaced by a current of neutrons with a Maxwellian energy distribution at temperature T entering from infinity. Experimental Physics: The fission cross section of $Pu^{241}$ was measured with the crystal spectrometer. Measurements were made over the energy interval 0.10 to 20 ev. Two mass spectrometers built to provide isotopic analyses of U and Pu were essentially completed and put into service. Some of the significant features of the instruments are described and their performance capabilities are indicated. Reactor Physics: Material buckling measurements were completed for a series of lattices with 1.92 and 2.50-inch diameter natural uranium fuel elements and, for most of the lattice spacings, with a tube-in-tube natural uranium fuel element. The measurements were made in exponential piles four feet long and approximately six feet wide. Bucklings were determined using both air and water coolants. Measurements were made in the PCTR of $k_\infty$ and f for a 1.923-in. diameter, solid natural uranium fuel element in an $8\frac{3}{8}$-in. square graphite lattice. Measurements were made with both air and $H_2O$ coolant. The preparation of $Lu_2O_3$-$Al_2O_3$ ceramic disks is discussed. Physics of Nuclear Safety: The values of $k_\infty$, as a function of moderation, are given for $UO_3$ and $UO_2(NO_3)_2$. The program of critical approach and exponential measurements of 3.063% enriched uranium rods in $H_2O$ was continued. A series of exponential experiments were begun to determine the quantity of neutron absorber needed in the water moderator to "safe" a heterogeneous system of enriched uranium. Experiments to determine the limiting concentration for which $k_\infty = 1$ for solutions containing $Pu^{239}$, $U^{235}$, and $U^{233}$ compounds are proposed. A study was made of the consequences of the maximum credible incident in a chemical dissolver charged with slightly enriched uranium. (For preceding period see HW-61181.) (W.D.M.)

**10873** KAPL-1210
Knolls Atomic Power Lab., Schenectady, N. Y.
REPORT OF THE NUCLEAR PHYSICS SECTION FOR JUNE, JULY, AUGUST 1954. Decl. Feb. 24, 1960. 55p. Contract W-31-109-Eng-52. OTS.

A group of tests was made on a ZnS—lucite scintillator for detecting fast fission neutrons from $U^{235}$. It is possible that such a detector will allow the presence of larger quantities of fissionable material than in conventional fission chambers because there is no limitation due to $\alpha$ pile-up. The measurement of $\eta$ and $\nu$ as a function of neutron energy is also indicated. Counting rates at low (20 ev) and high (1000 ev) energies were low, but improvement is anticipated by construction of a larger detector. Analytical work with the 2-stage magnetic analyzer was used to measure isotope abundances in samples as low as $2 \times 10^{-9}$ g. Single-stage analyzers were used for $B^{10}$ burnup measurements in irradiated $B_4C$ and the $U^{235}/Pu^{239}$ ratio of special fission detector plates for the Hanford crystal spectrometer. Several Pu-fueled power breeder reactor designs were analyzed by multigroup theory using a UNIVAC coding. Fuel and fertile materials in the metallic and oxide form were evaluated. Numerical results of critical mass and breeding ratio as a function of fuel and fertile material composition are presented. (For preceding period see KAPL-1155.) (W.D.M.)

**10874** KAPL-M-JHS-7
Knolls Atomic Power Lab., Schenectady, N. Y.
FLUX PEAKING FORMULAE FOR SOME TWO-DIMENSIONAL SYSTEMS. J. H. Smith. Feb. 9, 1960. 13p. OTS.

One-group diffusion theory is employed to obtain neutron flux distribution near the vertex of a wedge-shaped medium. While completely general results are very difficult to calculate, certain simple formulae can be developed for fairly accurate evaluation of flux peaking or depressions. A brief discussion of the theoretical technique is given; specific results are included for calculational reference. (auth)

**10875** KAPL-M-MEW-3
Knolls Atomic Power Lab., Schenectady, N. Y.
SLAB RECTIFIER CALCULATIONS. Margaret E. Way. Nov. 15, 1957. Decl. Feb. 24, 1960. 13p. Contract [W-31-109-Eng-52]. OTS.

In order to provide numerical checks of some features of the rectifier-amplifier theory, one dimensional, three group machine calculations were carried out for a single stage slab geometry rectifier reactor. The results show reasonable agreement with the theory and include a measure of the effect of non-uniform fuel loading in both the power and control zones. (auth)

**10876** KAPL-M-MLS-12
Knolls Atomic Power Lab., Schenectady, N. Y.
DISTRIBUTED REACTIVITY COEFFICIENTS IN A PMA SLAB CORE. MEASUREMENT AND ANALYSIS. N. E. French, R. F. Ruane, and M. L. Storm. Feb. 9, 1960. 50p. Contract W-31-109-Eng-52. OTS.

Measurements of the core distributed reactivity coefficients of moderator and structural materials that were made in a polyethylene moderated and reflected slab reactor (PMA-6) are described. In addition, the experiments are analyzed with the use of various cross section routines currently employed in nuclear design studies at this laboratory. The adequacy with which the WOX-type and 3-Group MUFT-SOFOCATE cross-section codes predict the experimental reactivity coefficient data is demonstrated. (auth)

**10877** LAMS-2387
Los Alamos Scientific Lab., N. Mex.
CALCULATED PROPERTIES OF Mu-MESONIC ATOMS. Kenneth W. Ford and John G. Wills. Nov. 24, 1959. 46p. Contract W-7405-eng-36. OTS.

The 2p → 1s transition energy is calculated for 34 elements in the periodic table from Be to U. The charge distribution used is a realistic 2 parameter distribution which gives agreement with electron scattering data, where such data exist. The binding energies, including vacuum polarization, of the 1s, 2s, and 2p levels are included for many of the elements as are quantities related to capture rates and magnetic moments. (auth)

**10878** NAA-SR-Memo-4788
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
NAA PROGRAM DESCRIPTION. CRYSTAL STRUCTURE CALCULATIONS. G. M. Wolten. Dec. 22, 1959. 14p. OTS.

Programs written in the FORTRAN system for use in calculating and indexing spacings from unit cell parameters in various crystal systems such as orthorhombic, monoclinic, etc., are described. The program can be used for verification of a tentatively chosen cell, for indexing x-ray-diffraction lines, for examining experimental patterns for extinctions, and for spotting impurity lines. The programs are described and listed. (J.R.D.)

**10879** NOLC-473
Naval Ordnance Lab., Corona, Calif.
INFRARED ATOMIC SPECTRA. C. J. Humphreys and E. Paul, Jr. [1959]. 12p. (NAVORD-473).

Reprinted from Foundational Research Projects Quarterly Report, July–September 1959.

Observation of the infrared spectrum of ytterbium is described. The 15,000-lines-per-inch John Hopkins grating was used in the spectrometer. Sufficient observations were made to permit coverage of the entire region between 10,000 and 25,000 A at least twice in the first order, together with second orders as they appeared in the same scans. (W.D.M.)

**10880** NP-8399
Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw.
L'EXTINCTION ET LE RENFORCEMENT DE LA LUMINESCENCE DU ZnS–Mn PAR L'IRRADIATION INFRAROUGE. (Extinction and Reinforcement of Luminescence of ZnS (Mn) by Infrared Radiation). Report No. 114/XIII. P. Jaszczyn. Oct. 1959. 14p.

Under the effect of infrared irradiation the blue luminescent band of ZnS(Mn) is extinguished and the orange band is reinforced. The effects are considerably smaller in the cubic crystals than in the hexagonal crystals. The introduction of cobalt to the phosphor reinforces the extinction of the blue emission and at the same time decreases the reinforcement of the orange emission. The mechanism of the energy transfer causing the extinction and reinforcement are discussed, and an energy model for ZnS(Mn) is proposed. In the model proposed, only the processes which start by the photoionization of the blue centers are considered. The effect of different infrared wavelengths on the luminescence is determined. The spectrum of the stationary luminescence under infrared irradiation was studied in the temperature interval from 20 to −150°C. These investigations showed that the reinforcement of the orange band results from two actions of the radiation: the liberation of holes and the liberation of electrons. (J.S.R.)

**10881** NP-8403
Kernreaktor Bau–und Betriebs-Gesellschaft m.b.H. Institut für Neutronenphysik und Reaktortechnik, Karlsruhe, Germany.
RESONANZEINFANG VON NEUTRONEN IN HETEROGENEN SYSTEMEN, INSBESONDERE IN BRENNSTOFFBUNDELN. (Resonance Capture of Neutrons in Heterogeneous Systems, Especially Fuel Bundles). Report No. 14. Gerd Blässer. Aug. 10, 1959. 48p.

The resonance capture of neutrons in heterogeneous systems is treated for clearly defined resonances in the Wigner approximation with the same accuracy as in homogeneous systems. An equation is obtained which incorporates all existing formulations to a treatment of resonance capture in heterogeneous systems as a special case. A general formulation is given for the calculation of the interaction between the various uranium blocks for small distances of the uranium blocks, a problem which has already been solved for the case of a narrow simple lattice of uranium plates. This problem is then solved generally for plate bundles. The equation is valid, independently of the special form of the resonance lines, under the single limitation that the resonance lines are small in comparison with a stopping interval in the moderator. An equation is given which contains as a limiting case the method of effective surfaces which was applied singly to a treatment of the resonance capture in double lattices of fuel elements. The equation, however, gave no support to the framework of a general resonance theory. The method of effective surfaces depends on the validity of "quadrilateral resonance." For small distances of the plates in the bundles, the case of the Breit-Wigner resonance was also considered. The values obtained are applied to rod bundles of equal surface/volume ratio and agree within measurement accuracy with the Hellstrand experiments. (tr-auth)

**10882** NP-8406
Pennsylvania. Univ., Philadelphia and Canada. Royal Military School, Kingston, Ont.
DIELECTRIC BREAKDOWN OF LIQUID HELIUM. Technical Report No. 4. C. Blank and M. H. Edwards. [1959]. 16p. Contract Nonr-551(28).

The dielectric strength of liquid $He^4$ under its saturated vapor pressure has been determined from 1.2 to 4.2°K. With $\frac{3}{8}$ inch diameter spherical steel electrodes 0.15 mm apart the average breakdown field, $\bar{E}_b$, is approximately 1 MV/cm, nearly independent of temperature. At spacings of 0.5 and 1 mm, $\bar{E}_b$ is lower, and appears to decrease with decreasing temperature below 2.5°K. The mechanism of breakdown is not clear, but field emission of electrons from the cathode is probably involved, because the average breakdown voltage $\overline{V}_b$, obtained with a point and plane electrode system when the point is negative, is about half that obtained when the point is positive, both above and below the λ-point. Pre-breakdown currents were never detected, and were probably less than $10^{-13}$ amp, implying an electrical resistivity for liquid helium of $10^{+18}$ ohm-cm. (auth)

**10883** NP-8434
Space Technology Labs., Inc. Physical Research Lab., Los Angeles.
MAGNETOHYDRODYNAMICS AND AERODYNAMIC HEATING. Rudolf X. Meyer. June 2, 1958. 30p. Contract AF04(647)-127.

The basic equations and some fundamental concepts of magnetoaerodynamics are discussed. The problem of the flow near the stagnation point of a body of revolution is reviewed and an exact solution is given. Data are presented for the heat transfer coefficient at the stagnation point, and for its gradient in the stagnation point region. The magnetic field strength required to accomplish an appreciable reduction of aerodynamic heating in hypersonic flight is discussed, for the case in which ionization is due to thermal motion. Methods which involve electrical breakdown of the air are considered. (auth)

**10884** NP-8454
Lockheed Nuclear Products, Marietta, Ga.
ABSOLUTE GAMMA COUNTING WITH A NaI (Tl) CRYSTAL SPECTROMETER. J. K. Grant. Jan. 1960. 15p. Contract AF33(600)-38947. (NR-84).

A method of determining the absolute gamma activity of neutron-irradiated foils is described. A NaI(Tl) crystal spectrometer was used for the counting. (W.D.M.)

**10885** ORO-253
Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.
IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. Technical Status Report No. 2 Covering Period December 1, 1959 to February 29, 1960. E. W. McDaniel, D. W. Martin, J. W. Hooper, and D. S. Harmer. 9p. Project No. B-176. Contract AT(40-1)-2591. OTS.

Objective of the research is the measurement of the cross sections for various ionization and charge transfer reactions of hydrogen atoms and ions incident on targets of H and He gas. The energy of the incident particles will range from 0.15 to 1.10 Mev. Source of the particles is a 1-Mev Van de Graaff positive ion accelerator, which is equipped with a beam analyzing and stabilizing system. The present status of the work is summarized briefly and future work is outlined. (For preceding period see ORO-220.) (W.D.M.)

**10886** RM-2317(RAND)
RAND Corp., Santa Monica, Calif.
ON ONE-DIMENSIONAL NEUTRON MULTIPLICATION. T. E. Harris. Jan. 18, 1960. 30p.

An idealized neutron-multiplication problem is treated in which neutrons move left or right in a one-dimensional body and undergo fission with doubling. The probability distribution of the total number of neutrons produced by an initial trigger neutron is examined. Special attention is given to the case where the length of the body is exactly critical. (auth)

**10887** SERL-TR-M-15
Gt. Brit. Services Electronics Research Lab., Baldock, Herts, England.
A COMPACT PULSED GENERATOR OF FAST NEUTRONS. P. O. Hawkins and R. W. Sutton. [195?]. 18p.

A study of the factors influencing the design of pulsed neutron generators is made. By using the reaction between tritium and deuterium, peak rates of $10^{13}$ per second should be obtainable from quite small sources. A method of keeping the pressure of deuterium gas substantially constant at the working pressure was evolved. This enabled a "sealed-off" and hence portable source to be made. The development of a fast neutron generator or neutron tube based on these considerations is described. This was capable of producing neutrons at a rate of $5.10^{12}$ per second at a voltage of 100 kv. The tube was suitable for operation at pulse lengths of 20 μsec, and the neutron content of each pulse was $10^8$. No difficulty was experienced in operating at one pulse per second and higher pulse repetition frequencies may be possible. (auth)

**10888** TID-5624
Illinois. Univ., Urbana.
ON THE LINEAR ANTIFERROMAGNETIC CHAIN. Technical Report No. 20. T. W. Ruijgrok and S. Rodriguez. Feb. 1960. 16p. Contract AT(11-1)-182. OTS.

The properties of the low-lying states of the antiferromagnetic chain are studied by means of a variational method. A trial wave function is exhibited which has an energy very close to that of the correct ground state and which displays a long-range order. (auth)

**10889** TID-5643
Ohio State Univ. Research Foundation, Columbus.
SOFT X-RAY SPECTRA OF METALS AND ALLOYS. Final Report for the Period July 1, 1951–June 30, 1959. C. H. Shaw and E. L. Jossem. Dec. 1959. 64p. RF Project No. 471. Contract AT(11-1)-191. OTS.

The L series x-ray emission and $L_{II, III}$ absorption spectra of Zr were studied in an attempt to elucidate the energy band structure of the valence electrons in this material. A two-crystal spectrometer equipped with quartz crystals was used to obtain the data. (W.D.M.)

**10890** TID-7571(p.27-38)
Martin Co. Nuclear Div., Baltimore.
RADIOISOTOPES AS SOURCES OF ELECTRICAL POWER. Jerome G. Morse. 12p.

Radioisotopes, particularly fission products, are under investigation as sources of electricity. The decay heat, resulting from the absorption of particulate and electromagnetic radiations in suitable containment, may be converted into electricity using such energy conversion devices as thermoelectric generators. Advantages and disadvantages of using radioisotopes as energy sources are reviewed. SNAP-III, fueled with polonium-210, is described and its performance characteristics are noted. The approach to using strontium-90 in small, remote land-based power plants is described. Potential applications of SNAP-III type devices are listed. (auth)

**10891** TID-7571(p.64-70)
Kansas. Univ., Lawrence.
SHORT-LIVED ISOTOPES FOR INDUSTRIAL PROBLEMS. R. B. Mesler. 7p.

The advantages of short-lived isotopes are discussed. A simple method is given for the estimation of specific activities which are induced by exposure to the neutron flux of a 10-kw reactor. (auth)

**10892** AEC-tr-3993
THE 7s, 6d, AND 5f ENERGY LEVELS OF ELEMENTS 90 to 100. C. G. Bedreag. Translated from Acad. rep. populare Romîne, Filiala Iaşi, Ştudii cercetări, ştinţ. 5, 87-94(1954). 8p.

The values of the levels 9s, 6d, and 5f of elements 90 to 100 taken from a previous note are qualitatively verified when compared with the data obtained by Goudsmit in 1933. (W.D.M.)

**10893** AEC-tr-4000
APPLICATION OF THE PHOTORESISTANCE OF CdS IN COMBINATION WITH PHOSPHORS AS A DETECTOR FOR COBALT-60 GAMMA RAYS. S. D. Margolin and I. G. Fakidov. Translated by S. W. O'Rear (Savannah River Lab.) from Doklady Akad. Nauk S.S.S.R. 105, 976-7(1955). 2p. JCL or LC.

Data are presented which show that crystals of cadmium sulfide in combination with phosphors can be used as a satisfactory detector of gamma rays with much shorter wave length than x rays. This type indicator requires a less complicated circuit and has greater specific sensitivity than do scintillation counters. (J.R.D.)

**10894** HW-tr-11
France. Commissariat à l'Énergie Atomique, Paris. STUDY OF $\gamma$ RADIATION FROM URANIUM RODS DURING DEACTIVATION. (Étude du Rayonnement $\gamma$ des Barres d'Uranium en Cours de Déactivation). F. Balestic. Translated by Liz Appleby (Hanford Atomic Products Operation) from report CEA-671, May 1957. 15p. JCL or LC.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 9508.

**10895** HW-tr-12
France. Commissariat à l'Énergie Atomique, Paris. NEW METHOD FOR DETERMINING THE THERMAL UTILIZATION FACTOR OF A CELL. (Nouvelle Methode de Determination du Facteur d'Utilisation Thermique d'une Cellule). A. Amouyal and P. Benoist. Translated by Liz Appleby (Hanford Atomic Products Operation) from report CEA-571, Apr. 16, 1956. 38p. JCL or LC.

This paper was previously abstracted from the original language and appears in NSA, Volume 10, as abstract No. 9599.

**10896**
EFFECTS OF INFRARED RADIATION ON ENERGY TRANSFER IN ZnS–Mn. Paulina Jaszczyn (Inst. of Physics, Polish Academy of Sciences, Wrocław). Acta Phys. Polon. 18, 427-38(1959). (In French)

A study was made of the effects of infrared radiation on the photoluminescence of ZnS(Mn) powder at −190°C. An attenuation of the blue band of the luminescence and an intensification of the orange band were found. The results of a study of the dependence of these effects may be summed up in saying that the activator concentration, the phosphor layer thickness, the wavelength, and the intensity of the exciting radiation as well as the infrared radiation show that the infrared rays affect the mechanism of energy-transfer by electrons and holes. (tr-auth)

**10897**
A NEW METHOD OF GAMMA BACKGROUND ERADICATION. J. Benisz and Z. Kierzkowski (Higher Pedagogical School, Katowice, Poland). Acta Phys. Polon. 18, 527-9(1959). (In English)

A new method of eradicating $\gamma$ background in nuclear emulsions is described which uses acetic acid. Some Agfa K-2, $100\mu$ plates were impregnated with Li citrate and irradiated with neutrons. Before Amidol development, they were impregnated with 0.1% acetic acid for times ranging from 10 to 180 min. The results were analyzed and indicated that a considerable decrease in $\gamma$ background was obtained. The number of grains in a proton or triton track was not changed by the treatment. (T.R.H.)

**10898**
THRESHOLD DISCONTINUITIES: APPLICATION TO X-RAY SCATTERING. Roger G. Newton and Luciano Fonda (Indiana Univ., Bloomington). Ann. Phys. (N. Y.) 9, 416-21(1960) Mar.

It is shown that the total cross section averaged over the Coulomb resonances is continuous at the threshold of a channel of two outgoing oppositely charged particles. An instance in which the effects discussed should be experimentally observable is the elastic scattering of x-rays near a photoelectric threshold. It is shown that the discontinuity in that case should equal the size of the photoeffect cross section. (auth)

**10899**
THE SLOW CHOPPER AND TIME-OF-FLIGHT SPECTROMETER IN THEORY AND EXPERIMENT. K. E. Larsson, U. Dahlborg, S. Holmryd, K. Otnes, and R. Stedman (Aktiebolaget Atomenergi, Stockholm). Arkiv Fysik 16, 199-217(1960). (In English)

The principles of chopper time-of-flight spectrometry are discussed. The chopper transmission as a function of neutron wavelength and of time was investigated. The case of the neutron emitting surface of height 2D at a distance L from the center of the chopper slit was studied. The construction, determination curve, and resolution and calibration of a time-of-flight spectrometer are discussed. (C.J.G.)

**10900**
IONIC PROPULSION. Robert H. Fox (Univ. of California, Livermore). Astronaut. Sci. Rev. 1, No. 3, 7-12(1959) July-Sept.

A description of the flight mechanics of both low and high acceleration for interplanetary missions is presented. It is shown that the low acceleration systems pay a large penalty in total momentum change requirements. An optimization procedure for low acceleration systems is given which leads to a simple relationship between mission requirements, payload fraction, power-plant specific power, and exhaust velocity. The energy limitation for electric propulsion systems utilizing a nuclear energy source is described and shown to give an upper limit to the missions of about $2 \times 10^5$ m/sec. It is shown that electric propulsion systems with a specific power capability of 0.1 kw/kg can compete favorably with chemical or heat exchanger type nuclear hydrogen rockets for the Mars round trip mission and are much superior for missions to the outer planets. The hardware problems associated with the attainment of a specific power of 0.1 kw/kg for an electric propulsion system are described. (auth)

**10901**
CALCULATIONS OF IRRADIATION SOURCES FOR POWERFUL ISOTOPIC INSTALLATIONS. N. I. Leshchinskiĭ. Atomnaya Energ. 8, 62-4(1960) Jan. (In Russian)

A series of formulas is suggested for calculating the radiation from arbitrary configurations when approximated as linear or point sources whose dosage is determined as an arithmetic sum of doses from each source. (R.V.J.)

**10902**
Co$^{60}$ GAMMA-RAY DOSAGE MEASUREMENTS IN THE NEIGHBORHOOD OF TWO MEDIA INTERFACE. V. I. Kukhtevich, B. P. Shemetenko, and B. I. Sinitsyn. Atomnaya Energ. 8, 66-8(1960) Jan. (In Russian)

Measurements were taken on the passage of $\gamma$ rays in water (medium I) near the interface with medium II (air, lead, nickel, and aluminum). The distance between the source and detector varied from 0.7 to 5.0 times the free path and the height of the source and detector was 0.05 to 2.0 the times $\gamma$-ray path in water. The measurements were made in a 2.0 × 2.2 × 1.6 m water tank. The dosage in water near the interface and the effects of the interface were plotted at various distances and heights. The order of the error did not exceed 3%. The results are correlated with published data derived by Monte Carlo methods. (R.V.J.)

**10903**

A STUDY OF ELECTROMOTIVE FORCE APPEARANCE IN THE SYSTEM SEMICONDUCTORS—URANIUM, IRRADIATED IN A NUCLEAR REACTOR. Yu. K. Gus'kov, A. V. Zvonarev, and V. P. Klychkova. Atomnaya Energ. 8, 72-5(1960) Jan. (In Russian)

Studies were conducted on semiconductors made up of $U_3O_8$ mixed with BaO, TiO, MgO, and $Al_2O_3$. The emf was observed in all specimens when exposed to reactor irradiation. The v-a characteristics of specimens were measured before and after exposure. The intensity of $v_\infty$ and of the current $I_{kz}$ increases with increased neutron flux density. The curves for the $U_3O_8$—MgO specimen show the $v_\infty$ saturation at nv = 6 × $10^{12}$ $cm^{-2}$ $sec^{-1}$ and $I_{kz}$ linearly increased with flux density. The load characteristics for the specimen are analogous to the characteristics of photoelements. The behavior of the $U_3O_8$—MgO specimen or a function of integral irradiation flux is plotted. Additional experiments were made in order to establish the participation of uranium fission fragments in the emf. Some of the specimens were irradiated by $\gamma$ rays before the reactor irradiation. In such cases the effect was smaller by a factor of three. A double specimen of $U_3O_8$—$Al_2O_3$ with one side coated with 10% $U^{235}$ enrichment and the other with natural U exhibited a 15-fold larger effect at the side coated by 10% $U^{235}$. In $U_3O_8$—MgO specimens, 0.01% of the uranium fission fragments was converted into electric energy. The data indicated that the emf is formed as a result of the valve effect; however, the volume and thermal emf also participate in the process. (R.V.J.)

**10904**

THE PRODUCTION OF RADIOACTIVE ISOTOPES. Peter Knoll (Zentralinstitut für Kernphysik, Dresden). Chem. Tech. (Leipzig) 12, 25-9(1960) Jan. (In German)

The utilization of reactors is discussed with a brief introduction to the nuclear physical fundamentals. The selection and preparation of targets and the production of single isotopes are considered. The field of application of radioisotopes is discussed, and the future potentials are reviewed. (J.S.R.)

**10905**

REFLECTION AND REFRACTION OF SHOCK WAVES IN MULTICOMPONENT MEDIA IN WATER. G. M. Lyakhov. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Mekh. i Mashinostr. No. 5, 58-63(1959) Sept.-Oct. (In Russian)

An analysis is made of shock wave motion in several media and of reflection and refraction at the boundary of two media and at a stationary barrier. (tr-auth)

**10906**

PROPAGATION OF A PLANE SHOCK WAVE IN GROUND. A. Ya. Sagomonyan (Moscow State Univ.). Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Mekh. i Mashinostr. No. 5, 64-71(1959) Sept.-Oct. (In Russian)

A mathematical analysis is made of plane shock wave propagation in plastic media. The selected media reflect the properties of sand and agrillaceous soil while offering a more efficient solution for problems arising in shock wave propagation in light soils. (R.V.J.)

**10907**

EFFECTIVE CROSS SECTIONS OF CERTAIN SPECTRAL LINES OF POTASSIUM AND ARGON. L. M. Volkova (Lomonosov Moscow State Univ.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 968-70(1959) Aug. (In Russian)

The effective cross sections of potassium and argon spectral line excitations are determined as the function of the incoming electron energy. The energy spread in the electron beam was nearly 0.8 ev. The measurements were made under 1.3 × $10^{-4}$ mm mercury. The excitation functions were measured by photometric and photoelectric methods using an ISP-51 spectrograph with $F_2$ = 2700 mm chamber. (R.V.J.)

**10908**

HIGH-ENERGY SPUTTERING. O. C. Yonts, C. E. Normand, and Don E. Harrison, Jr. (Oak Ridge National Lab., Tenn.). J. Appl. Phys. 31, 447-50(1960) Mar.

Sputtering ratios for copper were determined in the energy ranges 5 to 40 kev for bombardment by $Ar^+$, $He^+$, and $D^+$. Argon values range from 6.48 at 5 kev to 9.25 at 27.5 kev, deuterium from 0.048 at 10 kev to 0.023 at 44 kev, and helium from 0.23 at 15 kev to 0.75 at 40 kev. Preliminary data are included for 30-kev sputtering of copper by $H^+$(0.011), $D^+$(0.03), $He^+$(0.13), $N^+$(5.28), $Ne^+$(3.61), $Ar^+$(9.02), $Cu^+$(9.60), $Kr^+$(15.15), and $U^+$(20.9). Also included are sputtering ratios at 30 kev for $Ar^+$ on Ta(2.7), Mo(3.31), and Al(2.38). Most of these data are the result of a single measurement and require further verification. A definite pressure dependence of the sputtering ratio for $Ar^+$ on Cu was found in the range of 0.04 to 0.08 $\mu$. (auth)

**10909**

EFFECT OF PRESSURE ON PHOSPHOR DECAY. D. W. Gregg and H. G. Drickamer (Univ. of Illinois, Urbana). J. Appl. Phys. 31, 494-6(1960) Mar.

An apparatus was developed to measure the effect of pressure to over 50,000 atmospheres on the decay rate of phosphors. Three manganese activated phosphors with exponential decay curves were studied. In two cases the rate of decay decreased, in the third case it increased. A tentative explanation is offered. An hexagonal ZnS:Cu phosphor showed little pressure effect to 40,000 atmospheres at which pressure it transformed irreversibly to the cubic form with a sharp increase in decay rate and a large decrease in intensity. (auth)

**10910**

PRODUCTION OF VERY HIGH MAGNETIC FIELDS BY IMPLOSION. C. M. Fowler, W. B. Garn, and R. S. Caird (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys. 31, 588-94(1960) Mar.

Magnetic fields are produced in the 10 to 15 megagauss range by use of high explosives which compress the flux obtained from initial fields of approximately a hundred thousand gauss. The fields described here occupy a cylindrical volume and are essentially axial. A typical field might have these general characteristics: Peak field 14 megagauss; 2 $\mu$sec duration from 10 to 14 megagauss; field volume around peak, 6 mm diameter, 50 mm estimated length. (auth)

**10911**

THEORY OF FLUORESCENCE TIME CONSTANT MEASUREMENTS IN LIQUID AND RIGID SOLUTIONS. Hartmut Kallmann (New York Univ.). Phys. Rev. 117, 36-8(1960) Jan. 1.

Formulas are derived for the dependence of fluorescence upon time for the case when energy transfer from the solvent to the solute is involved. Three cases are considered: excitation by single fast particles, excitation by one burst of particles during a given period, and periodic excitation. One important point is that in the rise and decay of fluorescence from a burst of particles, it is the difference of two exponential functions and not their sum which occurs. The results are compared with the experiments of Burton and Dreeskamp, of Swank and Buck, and of Knau. These experiments are in general accordance with the derived formulas. (auth)

**10912**

HE II FILM PROFILE AND RELATIVE IMPORTANCE OF HEIGHT AND SURFACE PRESSURE. O. T. Anderson, D. H. Liebenberg, and J. R. Dillinger (Univ. of Wisconsin, Madison). Phys. Rev. 117, 39-42(1960) Jan. 1.

The thickness d of the He II film at 1.40°K vs. height h to 40 cm was measured by an optical method. Results agree better with an expression of the form $d = kh^{-1/3}$ than with $d = kh^{-1/2}$ or $h = (a/d)^3 + (b/d)^2$. Evidence was obtained suggesting that the contour of the film cannot be accounted for by considering it to be an adsorbed film subjected to a varying pressure. The pressure would decrease with height due to gravitational effects in a vertical gas column. (auth)

**10913**

SOME THERMAL PROPERTIES OF LIQUID HELIUM THREE. Louis Goldstein (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. 117, 375-81(1960) Jan. 15.

The various anomalies exhibited by the thermal properties of liquid $He^3$ originate with its nuclear spin system according to the statistical thermodynamic formalism elaborated for the latter. This result of general character is verified directly through a quantitative evaluation of the volume expansion coefficient of the saturated liquid. The theory also yields the explanation of the observed pressure dependence of the temperature locus of its volume anomalies near saturation at moderate pressures. The quantitative extension of the theory into the regions of the compressed liquid and the solid will have to await the forthcoming of precise measurements of several thermal properties in these phases of $He^3$. (auth)

**10914**

MAGNETIC COUPLING IN CRYSTALLINE COMPOUNDS. A PHENOMENOLOGICAL THEORY OF MAGNETISM IN 3d METALS. E. O. Wollan (Oak Ridge National Lab., Tenn.). Phys. Rev. 117, 387-401(1960) Jan. 15.

Magnetic coupling processes are considered in terms of the orbitals which result from the splitting of the d levels by the crystalline field. It is shown that the antiferromagnetic and ferromagnetic structure properties of many crystalline compounds can be qualitatively accounted for on the basis of indirect coupling processes which depend on the overlap of magnetic cation d orbitals with p orbitals of intervening anions and on the electron spin occupation appropriate to the particular cations involved. The orbital approach was used in considering the magnetic properties of the 3d metals and a coupling mechanism was proposed which is consistent with much of the magnetic data relating to the iron group metals and their alloys. (auth)

**10915**

PRODUCTION OF $H^-(1s^2)$ BY HYDROGEN ATOM COLLISIONS. Robert A. Mapleton (Air Force Cambridge Research Center, Bedford, Mass.). Phys. Rev. 117, 479-85 (1960) Jan. 15.

The post matrix element form of Born's approximation is used to calculate the cross section for $H^-(1s^2)$ production in hydrogen atom collisions. The Coulomb wave function is approximated by a plane wave, and two different wave functions derived by Chandrasekhar, one of which contains the inter-electron distance, are used for the $H^-$ state. The value of the cross section obtained with the wave function containing the interelectron distance term is roughly 25% larger than the other cross section. Since the direct and exchange charge transfer amplitudes, $f_s(\theta)$ and $f_s(\pi-\theta)$, are sharply peaked about $\theta = 0$ and $\theta = \pi$, respectively, the interference terms are negligible. Thus, only $f_s(\theta)$ has to be calculated to obtain the cross section. (auth)

**10916**

RANGE STRAGGLING OF CHARGED PARTICLES IN Be, C, Al, Cu, Pb, AND AIR. R. M. Sternheimer (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 117, 485-8(1960) Jan. 15.

The straggling of the range of charged particles due to fluctuations of the ionization loss was evaluated for six substances (Be, C, Al, Cu, Pb, and air). The calculations extend up to $T/\mu c^2 \sim 100$, where T is the kinetic energy and $\mu$ is the mass of the incident particle. At high energies ($T/\mu c^2 \gtrsim 5$), the integral giving the range straggling becomes somewhat dependent on the ratio $\mu/m$, where m is the electron mass. Two separate calculations were carried out, which apply to protons and $\mu$ mesons, respectively. The results for protons can be used for $\pi$ and K mesons in the energy range of interest ($T/\mu c^2 \lesssim 5$). (auth)

**10917**

RANGES AND ENERGY-LOSS PROCESSES OF HEAVY IONS IN EMULSION. Harry H. Heckman, Betty L. Perkins, William G. Simon, Frances M. Smith, and Walter H. Barkas (Univ. of California, Berkeley). Phys. Rev. 117, 544-56 (1960) Jan. 15.

The range-energy relations for C, N, O, Ne, and Ar ions in nuclear-track emulsion were measured for energies up to 10 Mev/nucleon. The ions, accelerated by the heavy-ion linear accelerator, were suitably degraded and subsequently analyzed by a 180° double-focusing magnetic spectrometer. The heavy-ion ranges were measured relative to those of alpha particles which were employed to calibrate the instrument. Within the energy interval studied, it was found that a general expression for the range of a heavy ion is $R = (M/z^2)\lambda(\beta) + Mz^{2/3}C_z(\beta/z)$, where $\lambda(\beta)$ is the range of a particle of proton mass and charge at velocity $\beta c$, $C_z(\beta/z)$ is an empirical function that corrects for the extension in range caused by neutralization of the ionic charge as electrons are captured at low velocities, and M and z are the ionic mass and charge in units of the proton. The range data are sufficiently complete and accurate to allow detailed analyses of rates of energy loss and effective charge of the heavy ions as they come to rest. The relative importance of primary and secondary ionization processes in producing the taper in the track of a multicharged ion has been studied by examining the ions in emulsions of various sensitivities. Buckling-type distortions of heavily ionizing tracks in strongly developed emulsions are also discussed. The range-energy relation for low-velocity protons is reexamined and an improved range point at 0.585 Mev is reported. (auth)

**10918**

AN EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE MAGNETIC FIELD PRODUCED BY RIDGED POLE-PIECES. P. F. Smith (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. C, Plasma Phys.—Accelerators—Thermonuclear Research 1, 55-65(1959) Oct.

An experimental investigation is described of the magnetic field distribution arising from straight parallel ridges of rectangular cross-section on the poles of a magnet. The 'field flutter' and 'mean gap' are defined and summarized graphically for an extensive range of ridge configurations, and for mean fields up to 20 kG. By comparison with the fields produced by spiral ridge configurations it is shown that the results are directly applicable to the design of the spiral ridge pole-pieces required by certain types of particle accelerator. The experimental investigation is supplemented by a number of theoretical calculations which enable the results to be extrapolated outside the range covered by the measurements. Brief discussions are included of the harmonic content of the field waveforms and of the use of ridge cross-sections other than rectangular. (auth)

**10919**

THE LUMINESCENCE OF THALLIUM-ACTIVATED POTASSIUM CHLORIDE PHOSPHORS. J. Ewles and R. V. Joshi (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), A254, 358-71(1960) Feb. 23.

New experimental investigations were made of the excitation, absorption, and emission spectra, phosphorescent decay curve characteristics, thermoluminescence, and photoconductivity of potassium chloride phosphors activated by thallium and of the thermoluminescence of potassium chloride phosphors activated by barium, by strontium, or by thermal or mechanical strains. It is concluded that for concentrations of more than about 0.001 mol. Tl the KCl: TlCl phosphors contain a number of different centers. Reasons are given for suggesting that some of these may be: (1) Tl$^+$ ions at substitutional sites and not near to other Tl$^+$ ions at neighboring positive ion sites, (2) TlCl$_n$ complexes at special sites near defects or along dislocations, (3) lattice distortions produced by the incorporation of Tl$^+$ or other foreign ions. Since the main emission peaks appearing in the thermoluminescence of KCl: Tl at 200 and 300°K also occur in the KCl phosphors activated by barium, by strontium, or by thermal or mechanical strain, it would appear that the electron traps responsible for the phosphorescence of KCl: Tl cannot be, as Williams suggests, metastable levels in Tl ions. It is suggested that they are at lattice defects created either by Tl or other foreign ions or by thermal or mechanical strains. The complexity of the absorption, emission, and excitation spectra suggest that the existing theories (such as those of Williams and his co-workers and of Knox & Dexter) of the luminescence of KCl: Tl require further development. (auth)

**10920**

ON THE CALCULATION OF THE INDUCED CURRENT CAUSED BY THE ARBITRARY MOVEMENT OF CHARGED PARTICLES. V. I. Gaiduk. Radiotekh. i Elektron. 5, 239-54(1960) Feb. (In Russian)

The induced current formulas for arbitrary motion of continuously injected charged particles were derived on the basis of the Ramo-Schockley theorem for single-charge induced currents. These formulas are simple for the events where all escaping particles leave the system simultaneously; however, in events where some particles overtake others, they are expressed by Fourier components for periodic and non-periodic induced currents as functions of time. The obtained deductions are applicable to charge density, convection current density (at a point), and in general to additive actions of any arbitrary objects when only the action induced in the system is known. Studies were made of the electron efficiency factors and induced current harmonics of a generator with a retarding field and a monotron. It is shown that the first system is more efficient than the second.

**10921**

ON BRILLOUIN ELECTRON FLUX AND A BOUNDARY PARTICLE CONCEPTION. A. D. Vlasov. Radiotekh. i Elektron. 5, 264-8(1960) Feb. (In Russian)

It is shown that the widespread concept of calculating the stability of electron beams, with the assumption of boundary particles in the laminary electron motion, is not always correct and in some instances can lead to beams with unstable structure. (R.V.J.)

**10922**

EXPERIMENTAL INVESTIGATION OF A KLYSTRON FREQUENCY DIVIDER WITH A PRELIMINARY BUNCHING. S. A. Kornilov and A. F. Emelyanov. Radiotekh. i Elektron. 5, 336-8(1960) Feb. (In Russian)

The efficiency of a klystron in dividing frequencies with more than two multiples was determined. A variation of the klystron frequency divider, using preliminary bunching on the controlling frequency with a reflecting generator used as regenerative section, was selected for the experimentation. The described klystron performs as a parametric electron-beam amplifier with variable beam-angle in a delaying field. (R.V.J.)

**10923**

SELECTIVE RADIATION COATINGS. PREPARATION AND HIGH TEMPERATURE STABILITY. Panos Kokoropoulos, Ehab Salam, and Farrington Daniels (Univ. of Wisconsin, Madison). Solar Energy 3, No. 4, 19-23(1959) Dec.

The preparation of selective radiation coatings by electroplating copper, cobalt, and other suitable metals on polished, reflecting metallic surfaces and oxidizing them by heating in air is described. Their emissivities and absorptivities for solar radiation were measured and their stability at high temperatures was investigated. (C.J.G.)

**10924**

INVESTIGATION OF THE "AURORAL AFTERGLOW" AND ITS PREPARATION STAGES. III. THE DECAY OF THE "AURORAL AFTERGLOW." Herbert Heinrich Brömer (Technische Hochschule, Brunswick). Z. Physik 158, 133-41(1960). (In German)

The intensity decay of negative bands of N$_2^+$ and of first positive bands of N$_2$ in the auroral afterglow was measured. An explanation possible for the decay curves of the first ones is proposed. By this the intensity decay in the beginning of the afterglow at high ionic densities is determined by the recombination of N$_2^+$ with electrons. Later, the ambipolar diffusion of the charge carriers to the wall causes the time dependence. A value of the ambipolar diffusion coefficient in nitrogen, derived from measurements, is given by the relation $D_a \times p \approx 124$ cm$^2$ sec$^{-1}$ Torr. The temperature of the charge carriers is estimated to be 313°K. The intensity decay of the first possible group in the afterglow seems mainly to be due to the diffusion of metastable particles to the wall. (auth)

**10925**

THE EFFECT OF THE EXCITATION WAVE LENGTH ON THE ELECTROPHOTOLUMINESCENCE. H. Gobrecht and H.-E. Gumlich (Technische Universität, Berlin). Z. Physik 158, 226-41(1960). (In German)

The electrophotoluminescence of manganese-activated zinc sulfide was investigated in dependence on the wave length of the exciting ultraviolet light. It is shown that a field amplification of the yellow manganese line occurs when the exitation energy was absorbed in the basic cell. In absorption in the long-waved branch of the basic cell absorption the manganese luminescence was extinguished by electric fields. The excitation energy was absorbed directly by the activators so that the electric field has no effect on the emission. The transition from field amplification to field extinction is shifted more to the long-waved absorption range with higher excitation. The blue emission was weakened by the electric field both in excitation under and over the absorption boundary of ZnS. In connection with these observations and in agreement with earlier measurements a model was suggested that the field amplification and field extinction of the luminescence of manganese-activated zinc sulfide serve for energy transfer in the basic cell. It was assumed that the electric field of the electrons raises the forbidden zone from the valence band in energy stages and therefore decreases the number of radiationless transitions and those bound with the blue emission. Consequently the number of recombinations in the manganese centers increases. Simultaneously the electric field of the electron term under the conduction band empties and decreases the radiationless transition over fixed sites. The field amplification of the yellow emission causes the transfer out of the charge carriers in the boundary layer of the luminescent crystallites so that preferred radiationless transitions occur. (tr-auth)

**10926**

MAGNETS FOR ORIENTATION OF ATOMIC NUCLEI WITH USE OF SUPER-CONDUCTORS. A. V. Kogan, V. D. Kulkov, L. P. Nikitin, and N. M. Reinov (Inst. of Physics and Tech., Academy of Sciences, USSR). Zhur. Tekh. Fiz. 29, 1419-20 (1959) Nov. (In Russian)

Polarization by the magnetic field of a superconducting niobium cylinder, with a critical field of 1800 gauss, was used in an investigation of oriented nuclei. The apparatus consists of a 0.1-mm thick, 60-mm wide niobium foil cylinder placed in liquid helium. During the adiabatic process of demagnitization, the outer field reaches a critical value and the constant field "freezes" to 800 gauss in the central part of the cylinder. The described method of developing magnetic fields requires no outside energy source, reducing the consumption of helium as compared to the electromagnet method. (R.V.J.)

**10927**

ION PROPULSION SYSTEMS: EXPERIMENTAL STUDIES. Sam Naiditch, R. M. Worlock, D. Zuccaro, D. Baker, M. P. Ernstene, L. R. Gallagher, J. Mullins, and J. A. Teem (Electro-Optical Systems, Inc., Pasadena, Calif.). Presented at the ARS 14th Annual Meeting, November 16-20, 1959, Washington, D. C. New York, American Rocket Society, 1959. 56p.

The development of various components of an ion motor is discussed. Alkali vapor flux to the ion source is controlled by electrolytic diffusion through a membrane. Both porous tungsten and staggered ribbon ion sources were studied and the effective area of the staggered ribbon source was measured experimentally. Both parallel-plate and Pierce-type accelerators were investigated. The modification of a two-dimensional accelerate-decelerate Pierce system by the inclusion of extra focusing electrodes to minimize ion interception by the electrodes is discussed. Analytical and analog studies of ion flow were made. Studies on the defocusing effects of the electrode apertures through which the beam passes were made with an elastic membrane potential analog and an electrolytic tank. Analyses of neutralization of an ionized beam by electrons and charge exchange are contained. (C.J.G.)

**10928**

EXPERIMENTAL ION SOURCES FOR PROPULSION. Sam Naiditch, R. C. Greenfield, L. R. Gallagher, and J. J. Rowlette (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Rocket Society, 1959. 14p.

Experimental studies on ion sources suitable for space propulsion are reviewed. The roles of energy, mass efficiencies, and material transport are outlined. Mass transport was found to produce electrode destruction, ionizing surface poisoning, insulation failure, and loss of electrical power due to electron feedback. Techniques developed to eliminate these problems are discussed together with experimental examples. Aspects of the ion source components in relation to the experimental results are analyzed. (auth)

**10929**

APPARATUS FOR PRODUCING BEAMS OF IONS OF A GIVEN ELEMENT. (to Commissariat a l'Energie Atomique and Centre National de la Recherche Scientifique). British Patent 829,783. Mar. 9, 1960.

An ion source is described which produces, accelerates, and focusses ion beams for such elements as Mo, Pd, Fe, and Cu. An ionized vapor of the element is drawn to a negatively charged electrode of the same element where ions are sputtered off and extracted by a magnetic field. (T.R.H.)

## Astrophysics and Cosmology

**10930**

STABILITY OF THE ADIABATIC MOTION OF CHARGED PARTICLES IN THE EARTH'S FIELD. Theodore G. Northrop and Edward Teller (Univ. of California, Livermore). Phys. Rev. 117, 215-25(1960) Jan. 1.

The motion of charged particles in a magnetic field such as that of the earth or that of a magnetic mirror machine is discussed. It is shown that during the motion and drift of a relativistic particle, not only the magnetic moment, but also a longitudinal invariant and an additional flux invariant are adiabatically conserved. These conservation laws lead to retention of the particles in the field. The derivation of the adiabatic invariants leads to a set of equations of motion which describe the average drift of the particles from one force line to the other, and which also describe the changes that occur in the energies and periods associated with the motion. In the absence of scattering, loss of particles from the magnetic field will be due to the violation of the adiabatic laws. (auth)

**10931**

ABSORPTION, REFRACTION, AND SCINTILLATION MEASUREMENTS AT 4700 Mc/s WITH A TRAVELING-WAVE TUBE RADIOMETER. John P. Castelli, Jules Aarons, Carl Ferioli, and Joseph Casey (Air Force Cambridge Research Center, Mass.). Planetary Space Sci. 1, 50-6(1959) Jan.

By means of radio astronomy techniques, measurements of atmospheric absorption, refraction, and scintillation were made at C band (4700 Mc/s), with the sun as a source of radiofrequency energy. The measurements were made with a comparison-type radiometer, using traveling-wave tubes, a tuned radio frequency receiver, and an altazimuth antenna mount. The average solar temperatures recorded for the period varied from 22,000°K at zero elevation to 26,000°K at 60° of elevation. Individual readings ranged between 18,000 and 30,000°K. The mean absorption, based on average solar temperatures at the various elevations for the period, was 0.00348 db/km. Refractive errors were approximately the same as optical although deviations from the mean during any day were large. Atmospheric scintillation for periods ranging from 0.5 to 90 sec were recorded. Scintillation amplitudes ranged from 2 to 20% of antenna signal temperature at low angles. At high elevation angles, scintillations rarely reached 10% and were generally less than 1%. (auth)

**10932**

THE DISTRIBUTION OF HELIUM-3 IN THE GRANT METEORITE AND A DETERMINATION OF THE ORIGINAL MASS. E. L. Fireman (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Planetary Space Sci. 1, 66-70(1959) Jan.

The distribution of $He^3$ in a slice of the Grant meteorite was determined by exposing it to slow neutrons and counting the converted tritium. The measured values ranged from $6.5 \times 10^{-6}$ to $5.1 \times 10^{-6}$ $cm^3/g$, with the highest value occurring near one edge of the slice. The $He^3$ isopleths corresponding to $5.7 \times 10^{-6}$ $cm^3/g$ or less form closed loops which are not circles. This indicated that the meteorite was not spherical when it was exposed to extraterrestrial cosmic radiation. The variation of the $He^3$ content with depth indicated that the average energy of the cosmic radiation to which it had been exposed was close to 6 Bev. These measurements indicate that the Grant meteorite, before it struck the earth's atmosphere, was a pear-shaped object with a mass of approximately 880 kg and that 400 kg ablated from the meteorite in its plunge through the atmosphere. (auth)

**10933**

STRONGLY ABSORBING LAYERS BELOW 50 km. Bengt Hultqvist and Johannes Ortner (Kiruna Geophysical Observatory, Sweden). Planetary Space Sci. 1, 193-204 (1959) Aug.

It is reported that very strong absorption of radio waves of very long duration following a solar flare were observed at Kiruna, Sweden during the summer of 1958. The height of the upper boundary of the ionized layer was found to be at about 50 km. It is shown that this height value accords well with what is to be expected if the ionizing agent consists of protons. An earlier proposed interpretation is discussed with regard to this height information. (auth)

**10934**

ON SOME CHARACTERISTICS OF THE $E_s$–LAYER. M. Bossolasco and A. Elena (Università, Genoa). Planetary Space Sci. 1, 205-12(1959) Aug.

Some aspects of the dependence of the $E_s$-ionization on the geomagnetic field are derived. An attempt is made to deduce the mean world-wide drift direction of $E_s$ in summer, using the time displacement that occurs for the daily maxima of the hourly median values of $f_0E_s$. (auth)

**10935**

ARTIFICIAL ELECTRON CLOUDS. I. SUMMARY REPORT ON THE CREATION OF ARTIFICIAL ELECTRON CLOUDS IN THE UPPER ATMOSPHERE. F. F. Marmo, L. M. Aschenbrand, and J. Pressman (Air Force Cambridge Research Center, Bedford, Mass.). Planetary Space Sci. 1, 227-37(1959) Aug.

The problems associated with the creation of artificial electron clouds in the upper atmosphere were studied. A series of rocket experiments was performed whereby artificial electron clouds were produced between 70 and 130 km. The ground-based detection networks that were employed are discussed, and a method of correlating both optical and radio-radar data is included. Some scientific uses of artificial electron clouds are discussed. (auth)

**10936**

ARTIFICIAL ELECTRON CLOUDS. II. GENERAL CONSIDERATIONS. F. F. Marmo, J. Pressman, and L. M. Aschenbrand (Air Force Cambridge Research Center, Bedford, Mass.). Planetary Space Sci. 1, 291-305(1959) Sept.

The creation of artificial electron clouds by the ejection of proper contaminants into the upper atmosphere is discussed. A square-well model is used to describe the distribution of the ejected contaminant immediately after the fast initial expansion. The diffusion equation is applied to this model and the salient features are noted. Basic equations are applied to this simplified model to describe the electron generative and decay processes on a term-by-term basis. Chemical consumption of the alkali metal contaminant by reaction with the ambient species was found to be negligible above 95 km. It is concluded that for generation methods similar to those outlined here the practical altitude limits of generation of long lived electron clouds is between about 70 and 200 km; chemical consumption determines the lower while the diffusion process establishes the upper limit. (auth)

**10937**

ARTIFICIAL ELECTRON CLOUDS. III. RELEASE OF ATOMIC POTASSIUM AT 121 km. F. F. Marmo, L. M. Aschenbrand, and J. Pressman (Geophysics Corp. of America, Boston). Planetary Space Sci. 1, 306-18(1959) Sept.

The results of the first successful rocket seeding experiment expressly designed for the generation of an optimum type artificial electron cloud are reported. The analysis and interpretation of the data were successfully accomplished by assigning the initial ionization to thermal effects after which solar photoionization of the released contaminant predominates. This was achieved by the daytime release of atomic potassium at an altitude of 121 km. A best fit of experimental data was dependent on varying sensitivity and extent of several parameters. These include the effective diffusion coefficient, the thermal ionization efficiency, the initial half width of the electron cloud, and the chemical yield. Approximate values for these are deduced. C-3 ionosonde data on the change in cloud slant range with time was utilized to obtain a measure of the horizontal wind velocity at about 121 km; this value is about 78 m/sec. (auth)

## Cosmic Radiation

**10938** AFSWC-TN-59-15

Air Force Special Weapons Center, Kirtland AFB, N. Mex. and Lockheed Aircraft Corp. Missiles and Space [Div.], Sunnyvale, Calif.

COMPOSITION OF RADIATION TRAPPED IN THE GEOMAGNETIC FIELD AT ALTITUDES UP TO 1,000 KILOMETERS. Francis E. Holly and Richard G. Johnson. Mar. 1959. 17p. Project No. 7811. (AD-216354).

Investigations to determine the composition of the radiation in the Earth's geomagnetic field at 850 to 980 km were conducted. The energy distribution indicates that 99% of the radiation lies below the point corresponding to 600 kev for electrons. The high-energy component is composed of protons and accounts for less than 1% of the total radiation, while the remainder of the radiation is due primarily to electrons. (J.R.D.)

**10939**

ATMOSPHERIC EFFECTS AND PERIODICITIES OF THE COSMIC RADIATION MEASURED 8m BELOW GROUND. T. Sándor, A. Somogyi, and F. Telbisz (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung. 11, 205-7(1960). (In English)

During 1957, measurements were made of the penetrating component of cosmic radiation at 8m underground (17 mwe) using two small identical wide-angle telescopes. Absorption and decay coefficients were determined for 7 periods at the Budapest location, and solar daily variation was observed for four months. The amplitude and phase observations agreed with analogous values reported by others. (T.R.H.)

**10940**

ORIGIN OF COSMIC RADIATION. B. Peters (Tata Inst. of Fundamental Research, Bombay). Nuovo cimento (10) 14, Suppl. No. 2, 436-56(1959). (In English)

A theory is presented for the origin of radio noise and for the origin, acceleration, and propagation of cosmic radiation. This theory is based on information gained from the study of the properties of cosmic particles in the neighborhood of the earth and in the more distant portions of the universe. Explanations are presented as to how the properties were applied in the investigation of cosmic radiation origination by means of this theory. (B.O.G.)

**10941**

SOLAR FLARE EFFECTS ON COSMIC RAY INTENSITY. H. Ghielmetti, J. C. Anderson, J. M. Cardoso, J. R. Manzano, J. G. Roederer, and O. R. Santochi (Comisión Nacional de Energía Atómica, Buenos Aires). Nuovo cimento (10) 15, 87-98(1960) Jan. 1. (In English)

In order to look for small cosmic ray increases associated with the development of solar flares, data from two neutron monitors located in the Southern Hemisphere were analyzed. Solar flares of magnitude 2 or greater were selected, and the analysis was carried out for the detectors being located within the morning impact zones. The behavior of nucleonic intensity, corrected for superposed daily variation, did not show any significative increase over the zero hour. This result contrasts with that of Firor, but agrees with the more recent paper by Towle and Lockwood. In the present work and for one station, there appears a significative peak if another type of correction is applied. Another significative increase arises several hours after the onset of solar flares, closely peaked around the time of maximum in the mean daily variation. Data examined were extracted from records of the University of Tasmania at Mount Wellington (Hobart, Tasmania) and Mawson (Antarctica). The period investigated covers from July 1957 to August 1958. (auth)

**10942**

ON THE RELATIVE ABUNDANCES OF COSMIC RAY NUCLEI OF CHARGE $Z \geq 3$. C. M. Garelli, B. Quassiati, and M. Vigone (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10) 15, 121-9 (1960) Jan. 1. (In English)

The charge spectrum of heavy primaries ($Z \geq 3$) of cosmic radiation was measured in nuclear emulsion exposed in a high altitude balloon flight at a residual atmospheric thickness of about 6 g/cm$^2$. The fluxes of light, medium, and heavy nuclei at the top of the atmosphere, and the relative abundances of charges between $Z = 3$ and $Z = 14$, are given. (auth)

**10943**

LOW-ENERGY $\pi$ MESONS IN THE COSMIC RADIATION. Mircea Fotino (Univ. of California, Berkeley). Phys. Rev. 117, 243-6(1960) Jan. 1.

The intensity of $\pi$ mesons in the atmosphere is investigated in the energy region $E_{kin} \lesssim 50$ Mev at sea level and at mountain altitudes. Positive $\pi$ mesons coming to rest in an absorber-scintillator are identified by the characteristic $\pi$-$\mu$ decay. They are detected electronically and recorded photographically. The value 1.45 ± 0.09 is adopted for the negative-to-positive ratio at small energies. The omnidirectional intensities $J_\pi^\pm$ of slow positive $\pi$ mesons at sea level (91m), Echo Lake, Colorado (3260m), and Mt. Evans, Colorado (4310m) are found to be 0.0094 ± 0.0024, 0.098 ± 0.005, and 0.240 ± 0.011 g$^{-1}$day$^{-1}$, respectively. The altitude dependence of $J_\pi^\pm$, $J_\mu^\pm$ and $J_\pi^\pm/J_\mu^\pm$ is given and the attenuation length of slow $\pi$ mesons in the atmosphere found to be $L_a^\pi \approx 120-130$ g/cm$^2$ in this interval. A discussion covering most of the available results along the same line is presented. (auth)

**10944**

LARGE-ANGLE SCATTERING OF FAST $\mu$ MESONS. J. L. Lloyd and A. W. Wolfendale (Univ. of Durham, Eng.). Phys. Rev. 117, 247-9(1960) Jan. 1.

Experiments on cosmic-ray $\mu$ mesons over the past seven years have appeared to show "anomalous" scattering. This anomaly is a small excess of large-angle scattering over that expected on current nuclear models. A recent experiment by Fukui, Kitamura, and Watase failed to show the anomaly. The data given by Fukui et al. are re-examined and it is shown that their experiment is inconclusive. (auth)

**10945**

CHANGES IN THE DIFFERENTIAL RIGIDITY SPECTRUM OF PRIMARY COSMIC RAYS ASSOCIATED WITH LONG-TERM AND SHORT-TERM INTENSITY VARIATIONS. J. R. Storey (Univ. of Tasmania, Hobart). Phys. Rev. 117, 573-7 (1960) Jan. 15.

During June and July, 1958, the cosmic-ray nucleonic component was surveyed along the geographic longitude 147.5°E between geographic latitudes 10°S and 44°S ($\lambda$ = 19°S and 53°S) at atmospheric depth 475 g cm$^{-2}$ with a neutron monitor mounted in an aircraft. This route is substantially the same as one covered during similar surveys in July and August, 1957. The data were analyzed to yield long-term and short-term changes in the differential rigidity spectrum j(N), for N in the range 2.0 to 9.0 Bv. A power law, $\Delta j(N) \propto N^{-\beta} j(N)$, with $\beta = 1.3$, fits the observations for the long-term change between July, 1957 and July, 1958. For a single short-term variation in 1958 the value $\beta = 1.2$ was obtained, with evidence that $\beta$ decreases at higher rigidities ($N > 7.0$ Bv). A 1.5° northward shift of the south latitude knee between the two series of flights is reported. Finally, high-latitude intensity variations of the nucleonic component at 475 g cm$^{-2}$ are compared with variations observed with a neutron monitor at Hobart ($\lambda$ = 52°, 950 g cm$^{-2}$). A 1.0% change in intensity at Hobart is equivalent to a 1.8 ± 0.3% change at 475 g cm$^{-2}$, independently of the time scale of the variations. (auth)

**10946**

STUDY OF THE COSMIC-RAY SOFT COMPONENT BY THE 3rd SOVIET EARTH SATELLITE. S. N. Vernov, A. E. Chudakov, E. V. Gorchakov, J. L. Logachev, and

P. V. Vakulov (Academy of Sciences, Moscow). Planetary Space Sci. 1, 86-93(1959) Apr.

Measurements on cosmic radiation at high altitudes were made with a scintillation counter installed in an earth satellite. With this instrument the counting rate corresponding to the energy greater than 35 kev and the total ionization in the scintillator were measured. Two zones of high intensity radiation were observed. The first was observed on latitudes greater than 60° and altitudes above 300 km. Radiation in this "polar zone" consisted of electrons of energy about 100 kev and flux rate of $10^3$ to $10^4$ particles/cm$^2$ sec sterad (increasing with altitude). The second zone was observed on altitudes about 1000 km and latitudes not exceeding 50°. In this "equator zone" the ionization in the scintillator was 3 orders of magnitude greater than that due to cosmic rays. Strong dependence on latitude and longitude was assumed to be consistent with the symmetry of the zone relative to the inclined and displaced geomagnetic axis. Lower limits are given for the $\gamma$-radiation from the sun. (auth)

**10947**

ČERENKOV RADIATION IN THE ATMOSPHERE. J. V. Jelley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Planetary Space Sci. 1, 105-11(1959) Apr.

The observation of Cherenkov radiation in the atmosphere, produced by cosmic-ray air showers, is discussed. The light receiving apparatus used in detecting the radiation is described. Theoretical aspects of formation of the radiation are discussed. (C.J.G.)

**10948**

SIDEREAL ANISOTROPY OF HIGH ENERGY COSMIC RAYS. I. Escobar, V., N. Nerurkar, and R. Weil (Laboratorio de Fisica Cosmica de Chacaltaya, U.M.S.A., La Paz, Bolivia and Centro Brasilero de Pesquisas Fisicas, Rio de Janeiro). Planetary Space Sci. 1, 155-60 (1959) Aug.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, as abstract No. 5769.

**10949**

LOW FREQUENCY ELECTROMAGNETIC RADIATION ASSOCIATED WITH MAGNETIC DISTURBANCES. G. R. A. Ellis (Commonwealth Scientific and Industrial Research Organization, Camden, N.S.W., Australia). Planetary Space Sci. 1, 253-8(1959) Sept.

Continuous observations of the amplitude and spectrum of naturally occurring radiation in the band 2 to 40 kc/s were made during the period June to December, 1958 near Sydney, Australia. A large number of isolated noise bursts lasting for some hours were detected. The intensity ranged from $6 \times 10^{-19}$ to $6 \times 10^{-17}$W m$^{-2}$ (c/s)$^{-1}$ at 4.6 kc/s. Three main types of bursts were identified and classified on a basis of their spectra which usually extended from 3 to 5 kc/s, 4 to 8 kc/s, and 2 to 30 kc/s, respectively. Major bursts, which were always of the latter two types, were clearly associated with strong auroral and magnetic activity and some showed a reproducible sequence of amplitude variation lasting about 36 hours. On three occasions, a detailed correspondence between the intensity of the noise and of simultaneously occurring red oxygen airglow was observed. Theories of the origin of the noise are discussed. (auth)

**10950**

THE ASSOCIATION OF SOLAR RADIO BURSTS WITH AURORAL STREAMS. A. Maxwell, A. R. Thompson, and G. Garmire (Harvard Coll., Observatory, Fort Davis, Tex.). Planetary Space Sci. 1, 325-32(1959) Sept.

Slow drift (Type II) radio bursts from the sun are believed to be caused by a primary disturbance moving outward through the solar atmosphere with a velocity of about 1000 km/sec. Analysis of the 2 years, 1956 October 1 through 1958 September 30, over the sunspot maximum revealed that 45% of these bursts are associated with the subsequent occurrence of terrestrial aurorae and magnetic storms. The mean delay between the radio bursts and the terrestrial disturbances is 33 hr, which is in good accord with the velocity for the disturbing source as deduced from the radio data. Investigation of the properties of the individual slow drift bursts and their association with other solar radio and optical phenomena revealed no completely conclusive criteria to explain why only 45% of the bursts are geomagnetically important. The geomagnetic effects were enhanced, however, if the bursts occur near the equinoxes and if they were accompanied by a flare of importance 2 or 3, or by continuum (Type IV) radiation. In the reverse association, with radio data available for an average 14 hr daily, it is shown that at least 60% of magnetic storms are preceded within 4 days by a slow drift burst. (auth)

**10951**

IONIZING RADIATION DETECTED BY PIONEER II. A. Rosen, P. J. Coleman, Jr., and C. P. Sonett (Space Tech. Labs., Los Angeles). Planetary Space Sci. 1, 343-6(1959) Sept.

The total ionizing component of cosmic radiation was measured up to an altitude of 1550 km by Pioneer II. An upper bound to the ratio of average-to-minimum specific ionization was determined by comparing the ionization with the count-rate observations from the Explorer IV satellite. This result implied that protons are the predominant species which gave rise to the observed ionization. (auth)

## Criticality Studies

**10952** ANL-5321(Rev.)

Argonne National Lab., Lemont, Ill.

ON THE APPLICATION OF MULTIGROUP DIFFUSION THEORY TO FAST CRITICAL ASSEMBLIES. David Okrent. Sept. 1954. Decl. Feb. 24, 1960. 34p. Contract W-31-109-eng-38. OTS.

Multigroup diffusion theory predicts too high a critical mass for small, highly enriched, critical assemblies. An attempt to improve the accuracy of diffusion theory predictions for fast reactors is described. Transport cross sections were adjusted on the basis of multigroup comparison of the Lady Godiva Reactor by diffusion theory and by the asymptotic solution to the Boltzmann equation. In general, the predictions made by the adjusted cross sections were in very good agreement with experiment. The procedure described is not recommended as a panacea but indicates that modifications in elastic transport cross sections may make multigroup diffusion theory more applicable to a wide range of fast reactors. (T.R.H.)

**10953**

A METHOD OF EVALUATING CRITICAL PARAMETERS OF FISSILE BODIES WITH ARBITRARY SHAPE. V. G. Zagrafov. Atomnaya Energ. 8, 23-9(1960) Jan. (In Russian)

An approximation method is presented for determining critical parameters of arbitrarily shaped bodies or groups of bodies composed of fissionable materials. In contrast to the variation method, the suggested method is simple and offers a favorable safety factor in handling fissionable materials. The method is applied to fast neutrons and is satisfactorily described by a one-velocity approximation. (tr-auth)

## Elementary Particles

**10954** AERE-R-3141
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
NUCLEON-NUCLEON SCATTERING EXPERIMENTS. R. J. N. Phillips. Dec. 1959. 16p. BIS.

The possible nucleon-nucleon scattering measurements at a given angle are listed, with the information about the scattering matrix they contain. There are essentially twenty-five linearly independent measurements (although only nine can be wholly independent), of which only two require a polarized target. (auth)

**10955** AFOSR-TN-59-1314
Cambridge Univ., England.
LOW ENERGY PION PHENOMENA. Scientific Note No. 2. J. Hamilton and W. S. Woolcock. Oct. 1959. 34p. Contract AF61(052)-233.

The relation between low-energy pion-nucleon scattering and pion photoproduction is examined. Correct extrapolation to threshold of both the $\pi^+$ and $\pi^-$ photoproduction data gives agreement with theory. A recent new method for analyzing the scattering data is applied, giving $a_1 = 0.178$, $a_3 = -0.087$. Reasonable agreement with the Panofsky ratio P = 1.5 is obtained. An inner Coulomb correction to the scattering data helps to improve this agreement. The possibility of detecting a $\pi$-$\pi$ interaction by low-energy pion scattering is examined. A new dispersion relation connects the s- and p-wave phase shifts at low energies; this relation excludes some well known sets of phase shift curves. (auth)

**10956** BNL-4664
Brookhaven National Lab., Upton, N. Y.
ENERGY AND ANGULAR DISTRIBUTION OF PARTICLES PRODUCED BY 25-BEV PROTONS. R. M. Sternheimer. Feb. 18, 1960. 12p. (ADD-RMS-8).

The laboratory energy and angular distributions of particles produced by 25-Bev protons were previously calculated, subjected to certain assumptions about the corresponding distributions in the center-of-mass system. Recently, Hagedorn obtained the energy distributions in the cms which are expected from the Fermi statistical theory. The laboratory spectra were recalculated using Hagedorn's distributions in the cms and assuming isotropic production in the cms. (W.D.M.)

**10957** CERN-59-35
European Organization for Nuclear Research, Geneva.
STRANGE PARTICLE PHYSICS. Lectures given at CERN in 1958 and 1959. THEORY. B. d'Espagnat, J. M. Jauch, and Y. Yamaguchi. SELECTED EXPERIMENTAL TOPICS. L. Lederman and C. Peyrou. Nov. 10, 1959. 355p.

A series of lectures on strange particle physics was given in 1958—1959 to a group of CERN physicists planning experiments with the proton synchrotron. The objective was to familiarize the audience with those aspects of the theory of elementary particles which seem of most immediate use in strange particle physics. The attempts at a systematization of the most recent knowledge in the field are presented with some emphasis on those aspects of current theories which, due to a lack of experimental knowledge, are still controversial. Strong and weak interactions, theoretical studies, and structure of weak interactions in space-time are covered. (W.D.M.)

**10958** KAPL-M-PFZ-2
Knolls Atomic Power Lab., Schenectady, N. Y.
AGES AND SLOWING-DOWN DENSITIES FOR PROMPT AND DELAYED FISSION NEUTRONS IN $Zr-H_2O$ MIXTURES. P. F. Zweifel and S. R. Bigelow. Sept. 16, 1955. Decl. Feb. 24, 1960. 10p. Contract W-31-109-Eng-52. OTS.

Ages and slowing-down densities have been calculated for prompt fission neutrons and for a range of lethargies covering the delayed neutron spectrum for values of $B^2 = 0$, 0.003, 0.0045, and 0.006. Calculations were performed for 1 : 1 volume $Zr-H_2O$ mixtures at both 555 and 68°F. (auth)

**10959** NAA-SR-Memo-4327(Rev.)
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
CALCULATIONS WITH MULTIGROUP ADJOINTS. F. H. Clark. Nov. 9, 1959. 10p. OTS.

The use of adjoints in the first order perturbation calculations is described in detail. (W.L.H.)

**10960** NP-8397
Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics.
DISPERSION RELATIONS FOR PHOTOPRODUCTION OF $\pi^0$-MESONS ON DEUTERONS. V. Sachl. 1959. 15p. (P-428).

The dispersion relations for the process of the photoproduction of neutral mesons on deuterons are derived with the help of impulse approximation. The unobservable region beginning with the state of a free proton and neutron gives continuous spectrum at which no other poles exist. In this two-nucleon approximation, valid up to a maximum photon energy of 236 Mev the calculations including the recoil in the Breit's system for the nonforward scattering with the absolute value of the momentum $\vec{p}^2 = (\mu^2/4)(M/M + \mu)$ are carried out. The specialization of the results is given for the case of deuterons perpendicularly polarized to the direction of the propagation of mesons without the spin-flip part. (auth)

**10961** NP-8462
Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics.
ON THE D-MESON. Ding-chang Hsien. 1959. 7p. (P-439).

Processes most favorable for the production of D mesons are discussed, and experiments are proposed to determine the spin and parity of the D meson. (auth)

**10962** NP-8491
Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy.
ON A SYSTEMATICS OF ELEMENTARY PARTICLES IN VIEW OF POSSIBLE PROPERTIES OF THE $D^0$—MESON. I. V. Chuvilo. 1959. 5p. (P-442).

Indications of the existence of a neutral unstable particle with mass and decay modes analogous to $D^+$ mesons are pointed out. A table of bosons and fermions is then shown with arrangement according to transformation properties in isotopic space. The table shows that three isotopic singlets $D^+$, $D^0$, $D^-$ may be treated as three components of a vector in m-isospace. If one assumes that the $D^0$ of the table is the same as the $D^0$ indicated earlier, then it can be concluded that the isotopic singlet $D^0$ with strangeness = 0 which may quickly decay into pions undergoes a slow decay which leads to products with strangeness ±1, contradicting the original assumptions. The most probable reaction for production of $D^0$ is $\pi^- + p \to N + D^0$, the threshold being 0.7 to 0.8 Bev. (T.R.H.)

**10963** NP-8492
Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems.
PHASE SHIFT ANALYSIS OF $\pi$-MESON SCATTERING ON HYDROGEN AT 240-333 Mev. S. M. Korenchenko, N. I. Polumordvinova, G. T. Tentiukova, and V. G. Zinov. 1959. 23p. (P-431).

The results of phase shift analysis of experimental data on pion–nucleon scattering at 240 to 330 Mev are given. The isotopic spin formalism based on the charge independence hypothesis was used. Comparison with the dispersion relations was satisfactory. (T.R.H.)

**10964** OOR-2486-1
Cornell Univ., Ithaca, N. Y.
THE ANGULAR DISTRIBUTION OF THE SYNCHROTRON RADIATION IN THE EXTREME ULTRAVIOLET AND X-RAY REGIONS. Technical Report No. 1. D. H. Tomboulian. Jan. 1960. 51p. DA Project No. 5B99-01-004. Contract DA-30-069-ORD-2746.

The theory of synchrotron radiation was investigated. The well-known classical equation for the power radiated per unit solid angle into the Nth harmonic of the circular frequency is put into a form suitable for calculations, and the results from quantum theory are compared with this classical expression. Curves of the angular power distribution for four wavelengths in the region of most intense radiation are computed for a Cambridge-like accelerator at maximum energy. The polarization of this radiation and the angular distribution of the total power radiated into all wavelengths are calculated. (auth)

**10965** UCRL-5864-T
California. Univ., Livermore. Lawrence Radiation Lab.
RESONANCE ABSORPTION OF NEUTRONS IN THICK SHEETS OF MOLYBDENUM. E. Goldberg and F. A. Kloverstrom. [1959]. 3p. OTS.

Several experiments were performed to determine the effective resonance absorption integral for Mo as a function of the thickness of the Mo sheets. The results were compared to theoretical predictions to appraise the contribution for unresolved resonances. The resonance integrals were determined by placing Mo sheets in a critical assembly and finding the critical dimensions. (W.D.M.)

**10966** UCRL-9021
California. Univ., Berkeley. Lawrence Radiation Lab.
NUCLEAR PROPERTIES OF ANTINUCLEONS. (Nobel Lecture). Emilio Segrè. Dec. 10, 1959. 16p. Contract W-7405-eng-48. OTS.

A general review of antinucleon properties and reactions is presented. Experimental developments are discussed briefly and the host of new problems encountered upon the discovery of the antiproton is considered. (W.D.M.)

**10967** UCRL-9050
California. Univ., Berkeley. Lawrence Radiation Lab.
COVARIANT PHASE SPACE FACTORS FOR REACTIONS INVOLVING FOUR TO SIX SECONDARY PARTICLES. T. H. Hoang and Jonathan Young. Jan. 1960. 24p. Contract W-7405-eng-48. OTS.

A set of programs for computing covariant phase space factors using the IBM-605 is described. Originally the programs were written to investigate K production in antiproton annihilation in terms of the statistical model. They were written with enough flexibility to permit their use on similar problems involving four to six secondary particles of another nature provided the particles can be ordered so that the last two particles in the successive integrals are identical. (W.D.M.)

**10968**
THE PROBLEM OF THE "ANOMALOUS" MASS OF MUONS. G. Marx and K. L. Nagy (Inst. for Theoretical Physics, Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung. 11, 161-76(1960). (In English)

It is supposed that there exists an intermediately strong interaction between muons and kaons having the same form as that between nucleons and kaons. This interaction explains the relatively large mass of the muons. After fixing the values of the parameters appearing in the interaction other observable consequences, e.g., elastic and inelastic muon-nucleon scattering, anomalous muon magnetic moments are analyzed. These "anomalous" effects caused by the supposed interaction turn out to be small and thus do not seem to contradict the present experimental facts. Finally, other kaonic interactions are briefly analyzed. (auth)

**10969**
MESON-FERMION PV INTERACTION IN THE THIRRING MODEL. G. Pócsik (Inst. for Theoretical Physics, Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung. 11, 177-83(1960). (In English)

The PV-interaction of a self-coupled massless spinor field and a PS-meson field is discussed in one space dimension. It is proved that the field equations are exactly soluble. In the case of an unquantized (external) meson field the model is reducible to the Thirring model, but for a quantized meson field we get the well-known difficulty of the PV-coupling. (auth)

**10970**
ON ANOMALOUS MAGNETIC MOMENT OF NUCLEONS. Colber G. de Oliveira (Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro and Faculdade Nacional de Filosofia, Rio de Janeiro). Anais acad. brasil. cienc. 31, 181-90 (1960). (In English)

The mass operator formalism of Schwinger is used to evaluate the nucleon magnetic moments. The anomalous magnetic moment of nucleons due to pions can arise by $N \to N_c + \pi \to N$ or by $N \to N + \pi_c \to N$, in which c denotes the particle which interacts with constant external electromagnetic field. The contributions of these two cases are calculated. (T.R.H.)

**10971**
PAIR PRODUCTION IN THE FIELD OF THE ELECTRON FROM TOTAL PHOTON ABSORPTION IN LIQUID HYDROGEN FROM 155 Mev TO 255 Mev. W. B. Jones (General Electric Research Lab., Schenectady, N. Y.). Ann. Phys. (N. Y.) 9, 341-53(1960) Mar.

The transmission of liquid hydrogen for photons was measured in the energy range 155 to 255 Mev. An electron synchrotron was used as the radiation source and a magnetic pair spectrometer served as the photon detector. The total cross section of hydrogen for photons in the energy interval was nearly constant and had an average measured value of 18.7 ± 0.4 millibarns/atom. An analysis of the data indicates that the pair production cross section in the field of the electron is smaller by 0.5 ± 0.4 millibarn/electron than the pair production cross section in the field of the unscreened proton. (auth)

**10972**
MESONS AND THE STRUCTURE OF NUCLEONS. PART III. PION-NUCLEON SCATTERING. G. Costa and B. T. Feld (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.) 9, 354-72(1960) Mar.

The "atomic" model of the physical nucleons was used in a direct computation of the scattering of free pions by nucleons. The computation is analogous to the computation of the scattering of electrons by hydrogen atoms. Neglecting any pion-pion interaction, p-wave scattering phase shifts are computed in the Born approximation and also by an improved technique, for various assumptions concerning the interaction between a pion and the nucleon "core". The model is shown to be capable of reproducing the resonant scattering in the (3,3) isobar state, while predicting much smaller phase shifts for the other states. The results differ from the Chew-Low theory for the Born approximation in that a small, positive phase-shift for scattering in the (1,1) state is predicted; the experiments appear to favor the prediction. It is concluded that the same pion-nucleon interaction, which accounts for the properties of the ground (physical) nucleon state, leads to the observed low-energy pion-nucleon scattering. (auth)

**10973**

THE OPTICAL MODEL AND INELASTIC SCATTERING. Leonard S. Rodberg (Los Alamos Scientific Lab., N. Mex.). Ann. Phys. (N. Y.) 9, 373-90(1960) Mar.

Calculations of Levinson and Banerjee using the direct-interaction model for the inelastic scattering of protons indicated that the optical potential seen by the scattered particle is weaker than for the corresponding elastic scattering process. The scattering amplitude is derived and the "1/A-corrections" to it are examined. It is shown that these represent corrections to the optical potential and arise from the requirement that the contribution of a given target nucleon to the optical potential be removed when that nucleon is interacting directly with the incident particle. It is shown that the short range, symmetry-dependence and spin-dependence of nuclear forces can make this an important correction and can explain the Levinson-Banerjee reduction. It is also shown that the strength of the effective two-body interaction, or t-matrix, is in good agreement with the strength found by Levinson and Banerjee. The distorted-wave direct-interaction model is therefore capable of predicting the absolute magnitude of the inelastic cross section. (auth)

**10974**

SCATTERING LENGTH AND EFFECTIVE RANGE THEORY FOR MULTICHANNEL PROCESSES. Marc H. Ross and Gordon L. Shaw (Indiana Univ., Bloomington). Ann. Phys. (N. Y.) 9, 391-415(1960) Mar.

The threshold properties of a two-body system which is coupled to other two-body channels are investigated. The new channel when coupled to one open channel was examined. At the threshold of the new channel three real parameters (which describe the scattering amplitudes) are considered: the complex scattering length, the element $a = A - iB$ in the new channel, and the diagonal K matrix element in the old channel, c. The quantitative behavior of these parameters was established with respect to certain averaged strengths of the interactions. Application to the relation between the three actual parameters and the c that would apply if the coupling between the channels were turned off was investigated. Effective range expansions were found to exist for the three parameters. These range expansions have the same form as the familiar one-channel expansion, except that the coefficient, $r_0$ of the quadratic term in the expansion is now an effective range type integral multiplied by a factor depending on a and c. In the effective range expansion of a, it was found that if Im(1/a) is large (compared to a kinematical factor, roughly the momentum, $k_1$, in the old channel) $r_0$ will be large compared to the range of forces. A similar result is shown to apply for the effective range expansion of the length $c/k_1$. The usefulness of some of the relations are illustrated by solving exactly the problem in which the 2-channel system is described by 2 coupled Schrödinger equations with square well potentials. The scattering length was examined by means of a complex potential for the situation where there are many coupled channels. (auth)

**10975**

ON THE SLOWING DOWN OF NEUTRONS IN AN HOMOGENEOUS INFINITE MEDIUM. Vinicio C. Boffi (Comitato Nazionale per le Ricerche, Rome). Ann. Phys. (N. Y.) 9, 435-74(1960) Mar.

Neutron slowing down in an infinite homogeneous medium was studied relative to the integral and differential equations obeyed by a characteristic differential quantity, i.e., the average number of collisions a neutron experiences in an infinitesimal interval of lethargy. The slowing down without capture is considered and both the basic equations and the fundamental questions connected with the problem are discussed. The effects of constant capture are considered and the moderating properties of different media are compared. The slowing down with varying capture and the case of 1/v-capture are investigated. (auth)

**10976**

ON THE VECTOR BOSONS. W. Królikowski (Univ. of Warsaw and Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Bull. acad. polon. sci., Sér. sci., math., astron. et phys. 7, 729-31(1959). (In English)

A formalism for elementary particles in which a vector boson would mediate in weak interactions is extended to include vector bosons: the photon and the hypothetical intermediate particle. An analogy between vector bosons and light fermions is given. (C.J.G.)

**10977**

$\gamma$-RADIATION AT AIR-GROUND INTERFACES WITH DISTRIBUTED $Cs^{137}$ SOURCES. C. E. Clifford, J. A. Carruthers, and J. R. Cunningham (Defence Research Board, Shirley Bay, Ont.). Can. J. Phys. 38, 504-7(1960) Mar.

Measurements of the $\gamma$-ray dose due to distributed sources were made to study the absorption and scattering at the air-ground interface. Doses were determined at varying heights and radial distances from a $\gamma$ source on the ground. The source used was $Cs^{137}$, since its $\gamma$-ray energy (0.66 Mev) is close to the average energy of $\gamma$ rays from fission "fall-out." Some of the more important results of these measurements are compared with Berger's (1957) calculations for $Co^{60}$. (B.O.G.)

**10978**

A NOTE ON THE WATANABE THEORY OF WEAK INTERACTIONS. A. Vančura (Faculty of Technical and Nuclear Physics, Prague). Czechoslov. J. Phys. 10, 28-32(1960). (In English)

It is shown that according to the Watanabe theory of weak interactions a resonant scattering of electrons by protons must take place. The resonant energy depends on the mass $m_B$ of the intermediate boson. For $m_B = 2300$ $m_e$ this energy is about 213 Mev in the center of the mass system. The energy width at resonances is 1.4 Mev. (auth)

**10979**

SOME PROBLEMS IN THE THEORY OF RADIATION DIFFUSION. V. V. Sobolev. Doklady Akad. Nauk S.S.S.R. 129, 1265-8(1959) Dec. 21. (In Russian)

A mathematical analysis is made of three seemingly different radiation problems which in reality converge into analogous integral equations. The analysis and solutions are given for a semi-infinite medium consisting of plane-parallel layers, for the problem of a planetary spherical nebula with a star in the center, where the nebula thickness is much smaller than its radius, and for a homogeneous infinite medium with a point radiation source (for example a star in a gaseous or dust nebula). (R.V.J.)

**10980**

ON ($p\pi^{\pm}$) REACTIONS. A. K. Lavrukhina. Doklady Akad. Nauk S.S.S.R. 129, 1277-8(1959) Dec. 21. (In Russian)

The reactions $Si^{30}(p,\pi^{+})Si^{31}$ and $Cu^{65}(p,\pi^{-})Ga^{66}$ at proton energies of 200 to 600 Mev were previously identified by radiochemical methods. At maximum energy the cross section of the reactions is $\simeq 10^{-30}$ $cm^2$/nucleon. The identification of these reactions is in contradiction with existing concepts of nucleon-nucleon interactions at high energies. Explanations of the reactions in published literature assume the presence of fast proton interactions with complex nucleons in the nucleus. An analysis is made of the feasibility of utilizing the theory of peripheral interactions suggested by Kh. P. Babayan (International Conference on High Energy Physics, Kiev, July 15-25, 1959) where $10^{11}$ to $10^{12}$ ev particles interacting with iron nuclei spend all their energy on meson production. In such instances the consequent interactions of the primary particle with nuclear nucleons or their complexes do not take place. The observed ($p,\pi^{\pm}$) reactions in complex nuclei with small cross sections are the examples of peripheral interactions at high energies. (R.V.J.)

**10981**

SCATTERING OF SLOW NEUTRONS BY THE WATER MOLECULE. P. G. Khubchandani (Atomic Energy Establishment, Trombay, India) and A. Rahman (Tata Inst. of Fundamental Research, Bombay). J. Nuclear Energy, Pt. A, Reactor Sci. 11, 89-94(1960) Feb. (In English)

The elastic scattering of slow neutrons from the water molecule is calculated by considering it as a rigid asymmetric rotator, following the method of Goryunov (1957). The partial scattering from each rotational state is calculated separately since the incident neutron energy considered is of the same order of magnitude as the rotational level separation. It is shown that in taking the thermal average at T = 300°K the contribution to the elastic scattering from rotational states with quantum number $j \geq 4$ is not negligible, as was supposed by Goryunov. This is true also for the total scattering which was calculated for just one incident neutron energy 0.0006 ev. The calculation gives a value slightly higher than the experimental value and it is shown that this is due to the neglect of zero-point vibrations of the molecule. (auth)

**10982**

ABSORPTION OF $\pi^{+}$ MESONS OF ENERGY IN THE VICINITY OF 50 Mev BY CARBON NUCLEI. Jeanne Laberrigue-Frolow (Laboratoire de Physique Nucléaire, Orsay, France) and M. P. Balandin (Balandine) and S. Z. Otvinovski (Joint Inst. of Nuclear Research, Dubna, USSR). J. phys. radium 21, 54-8(1960) Jan. (In French)

Stars caused by the absorption of $\pi^{+}$ mesons of energy 50 ± 20 Mev in carbon nuclei are studied by means of a propane bubble chamber. The cross section is found to be 145 ± 36 mb. The distribution of these stars as a function of the number of prongs indicates a mean number of prongs 2.6 ± 0.3. There is a noticeable anisotropy in the angular distribution of prongs relative to the direction of the incoming $\pi^{+}$. The fundamental reason of this assymetry is, probably, due to quasi-elastic scattering of the $\pi^{+}$ on nucleons inside the nucleus before its absorption. The distribution of two prongs stars as a function of the angle between the two prongs is given. (auth)

**10983**

SCATTERING OF NEUTRONS BY PHONONS IN A MONOCRYSTAL. D. Cribier, B. Jacrot, and D. Saint-James (Centre d'Etudes Nucléaires, Saclay, France). J. phys. radium 21, 67-9(1960) Jan. (In French)

The vibration spectrum of copper monocrystals was studied by the scattering of slow neutrons by phonons. The experimental results obtained are compared with the experimental results obtained previously with x rays and with the White theoretical model. A study of the behavior of the cross section to determine the optimum experimental conditions showed that if in the incident beam there is a wave length for which there is an infinity of differential cross sections, the peak of the corresponding scattered beam is proportional to this wave length and not to the maximum of the incident beam. Graphs show the variation of the final wavelength of the neutrons as a function of the incident wave length. (J.S.R.)

**10984**

QUASI-ELASTIC SCATTERING OF COLD NEUTRONS BY WATER AND THE COEFFICIENT OF AUTOSCATTERING OF THE LIQUID. D. Cribier and B. Jacrot (Centre d'Études Nucléaires, Saclay, France). J. phys. radium 21, 69-71(1960) Jan. (In French)

The inelastic scattering of cold neutrons by light water was investigated. Experimentally the weakly inelastic scattering caused by fluctuations in the density of the liquid was detected. The scattering spectra obtained at water temperatures of 30 and 43°C are given. The experimental curve is compared with a theoretical one obtained using $D = 2.67 \times 10^{-5}$ $cm^2$/sec. The coefficients of autoscattering D obtained at the two temperatures are tabulated and compared with previous results. (J.S.R.)

**10985**

SPACE AND TIME REFLECTIONS IN RELATIVISTIC THEORY. Yu. M. Shirokov (Lebedev Physical Inst., Moscow). Nuclear Phys. 15, 1-12(1960) Feb. (1) (In English)

A complete classification of representations of the inhomogeneous Lorentz group is obtained including space reflections and time reflections of the Wigner type. The problem of the squares of various reflection operations for particles of semi-integer spin is investigated in detail. The general results thus obtained are compared with those obtained when superimposing additional requirements on the theory, notably, the requirements of the locality of the field operators. (auth)

**10986**

TYPES OF SYMMETRY OF ELEMENTARY PARTICLES. Yu. M. Shirokov (Moscow Univ.). Nuclear Phys. 15, 13-15 (1960) Feb. (1) (In English)

It is shown that five different types of symmetry relative to space-time reflections are possible for elementary particles. The treatment is based only on properties of relativistic invariance and does not depend on locality or any other specific properties of the equations of motion. It is shown that only two types of symmetry are possible for particles with a zero rest mass and a non-zero spin. (auth)

**10987**

A DERIVATION OF THE PAIRING-CORRELATION METHOD. B. F. Bayman (Univ. of Copenhagen). Nuclear Phys. 15, 33-8(1960) Feb. (1) (In English)

A discussion is given of the problem of a system of fermions moving in a set of single-particle orbits, and interacting by means of a pairing force. The Bardeen-Cooper-Schrieffer equations are derived by a method which exhibits their approximation as that inherent in the saddle-point method, and without the introduction of fluctuations in the number of particles. (auth)

**10988**

ON THE SPIN OF THE Σ-HYPERON. Shoichi Hori (Institut for Teoretisk Fysik, Copenhagen). Nuclear Phys. 15, 56-9(1960) Feb. (1) (In English)

The large asymmetry factor observed in the decay of the $\Sigma^+$-hyperon indicates that the spin J of the hyperon is either $\frac{1}{2}$ or $\frac{3}{2}$, when an inequality eq. ((1)) derived by Lee and Yang is taken into consideration. Nevertheless, the distribution function in the case of $J = \frac{3}{2}$ manifests a quite different behavior from that for $J = \frac{1}{2}$ when it is calculated taking into account the observed large value of the asymmetry factor. Thus, if the corresponding distribution curve could be measured experimentally, it would not be difficult to determine the spin of the Σ-hyperon. (auth)

**10989**

A SIMPLIFIED DEMONSTRATION OF WICK'S THEOREM IN STATISTICAL MECHANICS. Michel Gaudin (Centre d'Etudes Nucléaires, Saclay, France). Nuclear Phys. 15, 89-91(1960) Feb. (1). (In French)

A general demonstration of Wick's theorem concerning the mean value, in the sense of statistical mechanics, of the product of an operator of creation and annihilation of a boson or fermion system is presented. This theorem is proved directly by using the commutation rules. (B.O.G.)

**10990**

DISPERSIVE EFFECTS IN ELASTIC ELECTRON SCATTERING BY COMPLEX NUCLEI. K. Gottfried (Universitetets Institut for Teoretisk Fysik, Copenhagen). Nuclear Phys. 15, 92-101(1960) Feb. (1) (In English)

A Z-independent estimate of the validity of the conventional analysis of elastic electron scattering is made with the help of an optical potential. It is concluded that the dispersive corrections are always of order 1/137. (auth)

**10991**

PROOF OF DISPERSION RELATIONS FOR PION-HYPERON SCATTERING. Y. S. Jin (Office of Atomic Energy, Seoul, Korea). Nuclear Phys. 15, 102-7(1960) Feb. (1) (In English)

Proof of dispersion relations for elastic and inelastic pion-hyperon scattering $Y_1 + \pi_1 \rightarrow Y_2 + \pi_2$ (where Y is Λ- or Σ-hyperon) is presented. Though the mass-difference $M_\Sigma - M_\Lambda$ gives rise to a small unphysical region which survives even for the forward scattering, the method of Lehmann and Oehme and Taylor allows us to derive dispersion relations for these processes up to a momentum-transfer $2\mu^2$ or $3\mu^2$. (auth)

**10992**

LOW MASS ODD-ODD ISOMERS OF THALLIUM. B. Jung and G. Andersson (Univ. of Uppsala). Nuclear Phys. 15, 108-24(1960) Feb. (1) (In English)

Beta-spectrometer measurements on mass separated sources from synchrocyclotron bombardments of Hg and Tl with protons have yielded information about some previously unknown nucleides: (1.41 ± 0.02)h $Tl^{196m}$, (11 ± 2) min $Pb^{194}$, (32.8 ± 0.2)min $Tl^{194m}$, and (33.0 ± 0.5)min $Tl^{194}$. Reinvestigation of the internal branch of (1.87 ± 0.03)h $Tl^{198m}$ has shown that it is more complex than assumed earlier, suggesting the following level sequence: 7+ (544 kev), 3− (283 kev), 2− (260 kev), and 2− (ground state). In $Tl^{196}$ an analogous pattern is indicated: 7+ (395 kev), 3− (275 kev), 2− (241 kev), and 2− (ground state). No internal branch was found from $Tl^{194m}$, while about 4% I.T. can be calculated for $Tl^{196m}$ and about 55% I.T. for $Tl^{198m}$. Some systematic energy level trends are discussed. (auth)

**10993**

PION-NUCLEON SCATTERING. J. Ashkin (Carnegie Inst. of Tech., Pittsburgh). Nuovo cimento (10) 14, Suppl. No. 2, 221-41(1959). (In English)

A review is presented of classical pion physics. The interaction of pions with nucleons, which plays a certain part in the complex structure of strong interactions, is discussed. The consequences of a charge independence assumption for π-p scattering are discussed relative to total and differential cross sections for the $\pi^+ + p$ and $\pi^- + p$ collision processes. Phase shifts characterizing partial waves are analyzed for pion-nucleon scattering. (B.O.G.)

**10994**

FIXED-SOURCE MESON THEORY. B. Touschek (Università, Roma and Scuola di Perfezionamento in Fisica Nucleare, Rome). Nuovo cimento (10) 14, Suppl. No. 2, 242-58(1959). (In English)

An outline of the mathematical formalism underlying the fixed source theory of the interaction between pions and nucleons is presented, including a description of each participant of the interaction. Equations are derived for the scattering of mesons and nucleons for the S and T matrices. Derivations are presented for dispersion relations and for the Low equations. A phase analysis is presented for symmetry between spin and isotopic spin in the scattering matrices. (B.O.G.)

**10995**

LOW ENERGY PION PHYSICS. J. M. Cassels (The University, Liverpool). Nuovo cimento (10) 14, Suppl. No. 2, 259-77(1959). (In English)

Low-energy pion physics is defined as: reactions which take place at low (positive) energies; $\pi^-$ capture in hydrogen or deuterium; and the $\pi^-$ capture by heavier nuclei. The reactions which occur for these conditions are explained. The independence and symmetry of the charge are discussed in the phenomenological theory of the interactions. The zero energy ratios for the reaction rates were found in the T, R, and S transitions. It was shown that the pion is pseudoscalar. Mesonic x rays from more complicated nuclei than H and D are discussed. (B.O.G.)

**10996**

ELEMENTARY CONSIDERATIONS ON PHOTOMESON PRODUCTION. B. Touschek (Università, Rome and Scuola di Perfezionamento in Fisica Nucleare, Rome). Nuovo cimento (10) 14, Suppl. No. 2, 278-82(1959). (In English)

A strong connection is shown to exist between the photomesic effect and the scattering of mesons by nucleons. It is illustrated by showing that the phases for photoproduction are equal to the scattering phases. A theory is presented, the basic idea of which is the recognition of the necessity to take account of both final state correction (in the 33-state) and anomalous magnetic moment interaction in order to obtain an adequate description of photomesic phenomena. (B.O.G.)

**10997**

MESON PHENOMENA. S. Fubini (European Organization for Nuclear Research, Geneva). Nuovo cimento (10) 14, Suppl. No. 2, 283-309(1959). (In English)

Some aspects of the theory of pion-nucleon interactions are examined, based on a simplified version of the theory in which the nucleon is kept and can emit and absorb mesons in a p-wave state. The static meson theory describes the interaction of the meson field with the spin and isotopic spin of the fixed nucleon. Lectures are divided into: the structure of the pion-nucleon interaction Hamiltonian; the general description of the physical nucleon state; the theory predictions about pion-nucleon scattering; and the photoproduction of pions. (B.O.G.)

**10998**

STRANGE PARTICLES. J. Ashkin (Carnegie Inst. of Tech., Pittsburgh). Nuovo cimento (10) 14, Suppl. No. 2, 310-27(1959). (In English)

For increases in pion-nucleon collision energies beyond the 3/2, 3/2 resonance, the inelastic processes become more important. The most striking are the reactions in which K mesons and hyperons are produced. These particles are divided into photons, leptons, mesons, and baryons. They are listed with their respective masses and approximate life times. The assignment of isotopic spins and strangeness quantum numbers to the hyperons and K mesons is investigated. The differential and total cross sections for strange particle production in pion-proton collisions are studied. The determination of hyperon spin is investigated and the parity non-conservation in hyperon decay is demonstrated. (B.O.G.)

**10999**

WEAK INTERACTIONS OF FERMIONS. J. M. Cassels (Univ. of Liverpool). Nuovo cimento (10) 14, Suppl. No. 2, 328-39(1959). (In English)

A discussion is presented of the three fermion interactions which occur in the original form of the Puppi triangle. The interactions between particles are described in a Lorentz invariant way. Muon decay and $\beta$ decay of the pion for the legs of the Puppi triangle are discussed. (B.O.G.)

**11000**

PRESENT PROBLEMS IN THE THEORY OF WEAK INTERACTIONS. R. Gatto (Università, Rome). Nuovo cimento (10) 14, Suppl. No. 2, 340-68(1959). (In English)

A review is presented of some unsettled problems in the theory of weak interactions and some related speculations. The discussion is based on the hypotheses of the AV theory developed by Feynmann, Gell-Mann, Marshak, and Sudarshan. One difference in this, with respect to the older description, is that there are couplings of the different particle pairs to themselves, such as $(p\bar{n})(p\bar{n})$. The possible properties of the weak interactions in isotopic spin space are discussed. A hypothesis of renormalization is formulated for the vector strangeness-conserving current, according to the Feynmann-Gell-Mann proposal. The renormalization of the axial vector coupling constant problem is discussed. From the discussion it is seen that many points still remain to be clarified and more accurate experiments are needed. (B.O.G.)

**11001**

AN INTRODUCTION TO DISPERSION RELATIONS. E. Corinaldesi (University Coll. of North Staffordshire, Keele, Eng.). Nuovo cimento (10) 14, Suppl. No. 2, 369-84(1959). (In English)

The elements of dispersion relations, building up both the physical and mathematical background, which has come into prominence during the past few years are reviewed. Dispersion relations can be established in a variety of problems, ranging from the theory of electrical networks and the optics of dispersive media to potential scattering in non-relativistic wave mechanics, and finally to quantum electrodynamics and pion physics. The application of dispersion relations to scattering of photons by electrons and non-relativistic potential scattering is discussed. (B.O.G.)

**11002**

DISPERSION RELATIONS. W. Thirring (Universität, Bern). Nuovo cimento (10) 14, Suppl. No. 2, 385-400 (1959). (In English)

The analytics of dispersion relations are analyzed to show that a slight change in an analytic function on some interval of the real axis can change completely its analytic properties. Some restricted consequences of microscopic causality in field theory are considered in connection with the propagation of particles. In two-particle scattering the amplitude is expressed for a meson scattered by a nucleon and the analytic properties of the scattering amplitude are given. The scattering of massless particles (photons), $\pi$ mesons, and nucleons is considered as an application of dispersion relations. (B.O.G.)

**11003**

FIT TO DISPERSION RELATIONS OF PION-NUCLEON SCATTERING. G. Puppi (Università, Bologna). Nuovo cimento (10) 14, Suppl. No. 2, 401-7(1959). (In English)

Pion-nucleon scattering is described as the flipping and non-flipping of the spin and isotopic spin of the nucleon. These are expressed in terms of scattering amplitudes in pure isotopic spin states, and in turn are expressed in terms of phase shift. The basic assumptions needed for the dispersion theory to become more nearly a dynamical theory of the pion system are: causality, unitary condition, crossing theorem, high energy behavior of $\sigma\ (\omega)$, and behavior of $S(\omega)$, in the unphysical region, $O < \omega < \mu$. This dynamical theory must allow exact calculations of the four amplitudes of the pion system. Dispersion relations are utilized in the investigation of sign ambiguity of phase shifts, Fermi-Yang ambiguity of phase shifts, and the determination of the coupling constant $f^2$. The work of Puppi and Stanghellini in dispersion relations is briefly discussed. (B.O.G.)

**11004**

NUCLEON STRUCTURE. M. Cini (Università, Rome). Nuovo cimento (10) 14, Suppl. No. 2, 408-14(1959). (In English)

An investigation of the structure of the nucleon is presented from considerations of situations in which the physical nucleon absorbs the photon and changes its 4-momentum from p to p′ without losing its character of a free particle. Functions are derived which describe the charge and current distribution inside the nucleon. Small values of the momentum transfer q in the nucleon are considered. (B.O.G.)

**11005**

SYMMETRY PROPERTIES OF ELEMENTARY PARTICLES W. Thirring (Universität, Bern). Nuovo cimento (10) 14, Suppl. No. 2, 415-28(1959). (In English)

A discussion is presented on the symmetry properties of elementary particles. These properties are considered in order to assist in the solution of many-body problems. Quantum field theory is utilized in order to clarify the major aspects of the investigation. (B.O.G.)

**11006**

RESEARCH ON HIGH ENERGY NEGATIVE $\pi$-MESONS IN NUCLEAR EMULSION. D. J. Holthuizen and B. Jongejans (Universiteit, Amsterdam). Nuovo cimento (10) 14, Suppl. No. 2, 429-35(1959). (In English)

The results from research on high-energy mesons

($\pi^-$) in nuclear emulsions are discussed. At energies as high as several hundred Mev, the scattering amplitudes for $\pi$ mesons were investigated, and at still higher energies the various production processes for pions, K-mesons, and hyperons may be studied. The reaction $p + n \rightarrow p + p + \pi^-$ is used to calculate the highest energy of the $\pi$ mesons produced in the target by the internal proton beam. Another quantity investigated by area scanning was the mean free path for high-energy pion star production. (B.O.G.)

**11007**

THE "CATALYTIC" AND "PHOTO" DECAY MODES OF THE MUON. S. P. Rosen (Washington Univ., St. Louis). Nuovo cimento (10) 15, 7-17(1960) Jan. (In English)

It is shown that, on the basis of the usual baryon-lepton direct coupling theory, the catalytic ($\mu + N \rightarrow e + N$) and the photo ($\mu \rightarrow e + \gamma$) decays of the muon are expected to occur as second order processes in the effective weak interaction Hamiltonian, $\mathcal{H}_{weak}$. If the effective weak interaction itself arises as a consequence of the coupling of baryons and leptons to an intermediate heavy boson (X), these decays are essentially first order in $\mathcal{H}_{weak}$, and are predicted to go so fast as apparently to contradict experimental data, at least in the case of photo decay. Estimates of the rates of the catalytic and photo decays are given both on the direct coupling and on the X theories and a comparison with the available empirical limits on these rates is made. (auth)

**11008**

ELECTRONS FROM $\mu$-CAPTURE AND THE RADIUS OF FERMI INTERACTIONS. B. Jouvet and J.-C. Houard (Collège de France, Paris). Nuovo cimento (10) 15, 31-44(1960) Jan. 1. (In English)

The range of Fermi interactions is determined by measuring vacuum polarization effects resulting from Fermi couplings. A typical process is studied: the electron emission in muon capture, which would occur if neutrinos emitted in electron and $\mu$-capture were identical. Lower bounds of radii parameters of Fermi interactions are obtained from the actual measured ratio $(\mu \rightarrow e)/(\mu \rightarrow \nu)$. The implication of this ratio in the single intermediate boson Fermi interaction theories is discussed, and could be tested by the experiments of nuclei excitation by neutrinos. (auth)

**11009**

INVESTIGATION OF THE INVARIANCE GROUP IN THE THREE FUNDAMENTAL FIELDS MODEL. J. E. Wess (European Organization for Nuclear Research, Geneva). Nuovo cimento (10) 15, 52-72(1960) Jan. 1. (In English)

For a theory in which elementary particles are represented by products of fundamental fields, consequences of an invariance group are investigated. The invariance group is the three-by-three unitary group. Tensor-calculus is used to investigate the representations, quantum numbers are defined and it is tried to identify certain families of elementary particles with irreducible representations. (auth)

**11010**

THE FIELD-THEORETICAL DEFINITION OF NUCLEAR POTENTIAL. [PART] II. J. M. Charap and S. P. Fubini (European Organization for Nuclear Research, Geneva). Nuovo cimento (10) 15, 73-86(1960) Jan. 1. (In English)

The results of Part I are extended to include the exchange forces introduced by charged pions. It is shown that the scattering amplitude for a proton and neutron between which acts a potential with an exchange part, is related by symmetrization to that for the scattering of non-identical particles through an isotopic spin dependent potential. This enables the amplitude to be split into two parts, each of which obeys a Khuri-type dispersion relation if the appropriate momentum transfer is kept fixed. The method allows also the generalization of the Mandelstam representation to the case where exchange forces are present. A similar separation of the field-theoretic amplitude is possible into parts which satisfy one-dimensional dispersion relations without the pion singularities for negative energies. A comparison of the dispersion relations and the unitarity condition for the field theoretic amplitudes with those of the potential theory lead to a definition of the potential (which is partly direct, partly exchange) which is capable of simulating the field-theoretic amplitude for energies sufficiently below meson production threshold. (auth)

**11011**

HYPERFRAGMENT PRODUCTION IN K$^-$-MESON ABSORPTIONS AT REST IN NUCLEAR EMULSIONS. MESIC DECAYS. J. Sacton (Université Libre, Brussels). Nuovo cimento (10) 15, 110-20(1960) Jan. 1. (In English)

The results of an analysis of 26 mesic hyperfragment decays found in a sample of 2,236 K$^-$-meson stars (excluding $K_\rho$) are given. Nine hyperfragment decays were uniquely identified. Among these, a new decay mode of the ${}_\Lambda Li^8$ hyperfragment was observed. Mention is made of the possible existence of a ${}_\Lambda He^6$ hyperfragment. (auth)

**11012**

INCOMPATIBILITY BETWEEN THE RESTRICTED SYMMETRY HYPOTHESIS AND CERTAIN EXPERIMENTAL RESULTS. B. d'Espagnat and J. Prentki (European Organization for Nuclear Research, Geneva). Nuovo cimento (10) 15, 130-46(1960) Jan. 1. (In French)

Methods for testing global symmetry ($g_{NN\pi} = g_{\Lambda\Sigma\pi} = g_{\Sigma\Sigma\pi} = g_{\Xi\Xi\pi}$) and restricted symmetry ($g_{\Lambda\Sigma\pi} = g_{\Sigma\Sigma\pi}$) with the help of K$^-$p scattering and absorption data are discussed and an application to restricted symmetry is made. The principle of all the approximation methods that were used for that purpose is to infer some knowledge about the matrix elements pertaining to $\Sigma\pi$ scattering with K interactions present from the assumed knowledge of what these same matrix elements would be if the K interactions were switched off. It is shown (a) that there are at least two such methods: either one assumes that a rough equality holds between the $T_{\Sigma\pi,\Sigma\pi}$ (or $K_{\Sigma\pi,\Sigma\pi}$) matrix elements with and without K interactions, or one assumes that a similar equality holds between the $(T^{-1})_{\Sigma\pi,\Sigma\pi}$ matrix elements under the same conditions; (b) that when the K interactions are large enough to allow for appreciable absorption (which is experimentally the case) these two methods lead to essentially different results. This general remark already throws serious doubts on the usefulness of the global or restricted symmetry concepts as regards K-nucleon processes. It is interesting to investigate whether one of these approximations, or both, would lead to results compatible with the experimental data. It is shown (a) that assuming the validity of the 1-st method, a straightforward extension of Amati and Vitale's argument leads to incompatibility between restricted symmetry and the observed data; (b) that, if one assumes the validity of the second method, the arguments used by Salam to reject global symmetry can be extended to restricted symmetry and that, for quite different reasons than in (a), incompatibility with the experimental data also results. It is concluded that restricted symmetry is definitely not a useful concept as far as low energy K-p phenomena are considered; either it does not hold, or it is completely veiled by the K interactions. (auth)

**11013**

PROTON-PROTON SCATTERING PHASE SHIFTS AT 150 Mev. R. C. Stabler and E. L. Lomon (Cornell Univ., Ithaca, N. Y.). Nuovo cimento (10) 15, 150-2(1960) Jan. 1. (In English)

The results of a phase shift analysis of proton-proton scattering data at 150 Mev are reported. The Harvard cross section, polarization, and depolarization data were used in fitting with phase shifts up to F waves. (B.O.G.)

**11014**

TCP AS A SPACE REFLECTION. E. Lubkin (Univ. of California, Berkeley). Nuovo cimento (10) 15, 153-5(1960) Jan. 1. (In English)

A discussion is presented on the subject of TCP as a space reflection. How these observables transform under pure space reflection or "parity," P, pure charge conjugation, C, and pure time reversal, T, is discussed in connection with left-right symmetry and an orientation of 4-space. (B.O.G.)

**11015**

THE NON-RENORMALIZATION HYPOTHESIS FOR THE VECTOR $\beta$-DECAY AND RARE DECAY MODELS OF HYPERONS. N. Cabibbo and R. Gatto (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo cimento (10) 15, 159-62(1960) Jan. 1. (In English)

The non-renormalization hypothesis is discussed for the $\beta$ decay and rare decay models of hyperons. This hypothesis allows for the relation of some weak decay amplitudes to corresponding electromagnetic amplitudes. The relation was used to express the vector amplitude for $\Sigma^{\pm} \rightarrow \Lambda^0 + e^{\pm} \nu$ in terms of the $\Sigma^0 - \Lambda^0$ transition magnetic moment, which is used to determine the $\Sigma^0$ lifetime. The residuum of a pole in the amplitude for $\gamma + N \rightarrow Y + K$ reactions appears from this magnetic moment. (B.O.G.)

**11016**

DECAY ELECTRON SPECTRUM FROM BOUND $\mu^-$-MESONS. H. Überall (Carnegie Inst. of Tech., Pittsburgh). Nuovo cimento (10) 15, 163-5(1960) Jan. 1. (In English)

Experiments indicate that the binding of $\mu^-$ in the K shell of mesic atoms has a strong influence on the muon decay rate. A systematic evaluation was made of the $\mu^-$ decay electron spectrum for light nuclei, accurate up to the first power in $\gamma = Z/137$. The expected effects of muon binding, as compared to the decay of a free $\mu^+$ are listed. The decay electron spectra of bound $\mu^-$ mesons for $Z = 25$ are included. (B.O.G.)

**11017**

ON THE POSSIBLE EXISTENCE OF DOUBLY STRANGE HEAVY MESONS. J. C. Polkinghorne (Trinity Coll., Cambridge, Eng.) and A. Salam (Imperial Coll. of Science and Tech., London). Nuovo cimento (10) 15, 166-7(1960) Jan. 1. (In English)

Some theoretical implications of the possible existence of doubly strange heavy mesons of approximately 1500 electron masses are discussed. The charged $\omega$ – meson production from $\pi^- + p$ reactions is discussed for several pion momentum values. (B.O.G.)

**11018**

POSITRON ANNIHILATION IN METALS. S. Kahana (McGill Univ., Montreal). Phys. Rev. 117, 123-8(1960) Jan. 1.

A correlation function for a positron-electron pair within a metal is obtained by solving a Bethe-Goldstone equation. Thus one may take account of the many body effects, of screening and the exclusion principle, in computing the electron density at the position of the positron. The results indicate that one may, in this fashion, reconcile the Sommerfeld model of a metal with the experimental data on positron annihilation in metals. (auth)

**11019**

DETECTION OF THE FREE ANTINEUTRINO. F. Reines, C. L. Cowan, Jr., F. B. Harrison, A. D. McGuire, and H. W. Kruse (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. 117, 159-73(1960) Jan. 1.

The antineutrino absorption reaction $p(\bar{\nu},\beta^+)n$ was observed in two 200-liter water targets each placed between large liquid scintillation detectors and located near a powerful production fission reactor in an antineutrino flux of $1.2 \times 10^{13}$ cm$^{-2}$ sec$^{-1}$. The signal, a delayed-coincidence event consisting of the annihilation of the positron followed by the capture of the neutron in cadmium which was dissolved in the water target, was subjected to a variety of tests. These tests demonstrated that reactor-associated events occurred at the rate of 3.0 hr$^{-1}$ for both targets taken together, consistent with expectations; the first pulse of the pair was due to a positron; the second to a neutron; the signal depended on the presence of protons in the target; and the signal was not due to neutrons or gamma rays from the reactor. (auth)

**11020**

PLANE POLARIZATION OF 15.1-MEV BREMSSTRAHLUNG FROM 25-MEV ELECTRONS. D. Jamnik and P. Axel (Univ. of Illinois, Urbana). Phys. Rev. 117, 194-206(1960) Jan. 1.

Linearly polarized gamma rays were produced with the aid of a special betatron doughnut which made it possible to limit the effective thickness of the bremsstrahlung-producing Al and Pt targets. The linear polarization of 15.1-Mev bremsstrahlung gamma rays was detected by measuring the azimuthal angular distribution of gamma rays which were scattered elastically from the well-known nuclear level in $C^{12}$. For the particular effective thickness of Al that was used, the maximum polarization of 15.1-Mev gamma rays in the bremsstrahlung of 25-Mev electrons was 1.53 ± 0.05. (This corresponds to 21% in the more conventional polarization notation.) Both this observed maximum (which occurred at an angle of 1.4°) and the polarization measured at four other angles confirm theoretical predictions. With the platinum target that was used, the observed polarization of 1.28 ± 0.04 was about 10% lower than the value predicted by theoretical calculations which use the Born approximation and neglect screening. Available screening and Coulomb corrections bring the theoretical predictions into essential agreement with the experimental values. Since the elastic scattering pattern of gamma rays shows unambiguously that the strong photon scattering level at 15.1 Mev in $C^{12}$ is excited by magnetic dipole radiation, this level has spin 1 and even parity. (auth)

**11021**

PION-PROTON SCATTERING BELOW 150 MEV. [PART] I. S. W. Barnes, B. Rose, G. Giacomelli, J. Ring, K. Miyake, and K. Kinsey (Univ. of Rochester, N. Y.). Phys. Rev. 117, 226-37(1960) Jan. 1.

Positive-pion proton differential cross sections were measured at 41.5 Mev for six angles. The angles in the center-of-mass system are 53°, 69.1°, 100.4°, 128°, 141.7°, and 163.5° and the corresponding cross sections in mb/sterad in the center-of-mass system are 0.252 ± 0.020, 0.354 ± 0.025, 0.777 ± 0.038, 1.145 ± 0.067, 1.495 ± 0.084, and 1.750 ± 0.110. Negative pion elastic cross sections were measured for the first five of the above angles and are, respectively, in mb/sterad in the c.m. system: 0.338 ± 0.047, 0.281 ± 0.038, 0.148 ± 0.029, 0.112 ± 0.042, and 0.085 ± 0.25. Phase-shift analyses of these data and those of other authors lead to the following expressions for the low-energy behavior of the $T = {}^3\!/_2$ phases: $\alpha_{31}{}^N = -(0.0418 \pm 0.004)\eta^3$, $\alpha_3{}^N = -(0.1145 \pm 0.0026)\eta$, and $\cot\alpha_{33}{}^N = {}^4\!/_3\eta^3\ (0.0877 \pm 0.0014)/[\omega^*(1-\omega^*/2.17)]$. (auth)

**11022**

PION-PROTON SCATTERING BELOW 150 MEV. [PART] II. S. W. Barnes, H. Winick, K. Miyake, and K. Kinsey (Univ. of Rochester, N. Y.). Phys. Rev. 117, 238-42 (1960) Jan. 1.

Values found for 30-Mev scattering at the two center-of-mass angles 116.8° and 155° are, respectively, for positive pions 0.849 ± 0.048 and 1.098 ± 0.075 mb sterad$^{-1}$, and for negative pions of the same energy 0.187 ± 0.020 and 0.165 ± 0.022 mb sterad$^{-1}$. Phase-shift analyses are made of recent published $\pi^-$ distributions in the above energy range and serve to furnish prescriptions for the low-energy behavior of the $T = {}^1\!/_2$ phases. Calculations of $\sigma^{--}$, $\sigma^{-0}$, and $\sigma_{total}{}^-$ at various energies agree with measurements found in the literature. An essential agreement is found between $\pi^- + p$ forward scattering amplitudes and a dispersion equation over this energy region. (auth)

**11023**

$\pi^\pm$-p ELASTIC SCATTERING AT 30 MEV. G. Giacomelli (Univ. of Rochester, N. Y.). Phys. Rev. 117, 250-1(1960) Jan. 1.

Differential scattering cross sections in hydrogen for (30 ± 1.5)-Mev positive and negative pions were measured at the two center-of-mass angles of 82 and 99.9 degrees. The cross sections for positive pions in mb/sterad in the center-of-mass system are 0.435 ± 0.028 and 0.590 ± 0.030; for negative ones, 0.268 ± 0.028 and 0.239 ± 0.021, respectively. (auth)

**11024**

SCATTERING INVOLVING A BOUND STATE. Smio Tani (Case Inst. of Tech., Cleveland). Phys. Rev. 117, 252-60 (1960) Jan. 1.

Granting that the formation of a bound state is a "sudden" process (as compared to the scattering which may be regarded as a process taking place "adiabatically"), a formulation of the scattering involving a bound state is discussed, in which an independent set of creation-annihilation operators is introduced for a particle in the bound state. There appears here a subsidiary condition which prevents the system from having an unduly increased number of degrees of freedom. In the case of potential scattering, this subsidiary condition restricts the intermediate states in a multiple scattering process to states which are orthogonal to the bound state. This orthogonality condition gives rise to a simple explanation of the theorem concerning the scattering phase shift at zero energy, in which it is stated that when there is one bound state, the scattering phase shift starts with $\pi$ at zero energy, if it is to go down to zero at extreme high energy. (auth)

**11025**

ANALYTIC PROPERTIES OF PERTURBATION EXPANSIONS. J. C. Taylor (Imperial Coll. of Science and Tech., London). Phys. Rev. 117, 261-5(1960) Jan. 1.

A method is introduced for locating and interpreting the singularities in finite-order perturbation expansions of Green's functions, in cases where the external momenta are complex vectors with real scalar products. In particular, when the external momenta form a real Euclidean set, there is a simple graphical construction, applicable to all finite orders. As an example of a case in which the external momenta form a real set in a space of signature (+, +; –, –), a feature of Mandelstam's representation for scattering amplitudes is interpreted in perturbation theory. Finally, the ranges of values of momentum-transfer for which (in perturbation theory) dispersion relations certainly hold are enlarged, in particular by using the fact that the pion is pseudoscalar. (auth)

**11026**

STRUCTURE OF THE FORWARD SCATTERING AMPLITUDE. S. Deser (Brandeis Univ., Waltham, Mass.). and W. Gilbert and E. C. G. Sudarshan (Harvard Univ., Cambridge, Mass.). Phys. Rev. 117, 266-72(1960) Jan. 1.

The matrix elements of various products of two currents between states of equal energy-momentum are studied. Use of the axioms of local field theory leads to an integral representation for the Fourier transform of matrix elements of the retarded commutator in terms of two invariant momentum parameters. Further restriction on the class of allowed functions permits explicit incorporation of the mass restrictions as support conditions on the weight function. The "bound-state" term is separated off and related to the vertex functions. As a simple application, forward-scattering dispersion relations are derived by specialization of the Green's function. In particular, these can be obtained for nucleon-nucleon and K-meson-nucleon scattering. (auth)

**11027**

INTEGRAL REPRESENTATIONS OF TWO-POINT FUNCTIONS. S. Deser (Brandeis Univ., Waltham, Mass.) and W. Gilbert and E. C. G. Sudarshan (Harvard Univ., Cambridge, Mass.). Phys. Rev. 117, 273-9(1960) Jan. 1.

An integral representation for a general matrix element of two field operators between eigenstates labelled by an arbitrary number of momenta is presented. This representation is conveniently parametrized over a set of invariants related to the total momentum and momentum transfer, and explicitly incorporates spectral conditions. Physically interesting dispersion relations for off-forward scattering cannot be obtained from this representation alone. (auth)

**11028**

SOME ASPECTS OF THE COVARIANT TWO-BODY PROBLEM. II. THE SCATTERING PROBLEM. Susumu Okubo (Univ. of Rochester, N. Y.) and David Feldman (Brown Univ., Providence). Phys. Rev. 117, 292-306(1960) Jan. 1.

By way of extension of a previous study of the bound-state problem within the framework of the covariant Bethe-Salpeter formalism, the scattering of nucleons was investigated in the ladder approximation, assuming scalar nucleons and zero-mass scalar mesons. The solution of the scattering problem can be effected by using an integral-transform method which is similar to that developed for the bound-state problem, subject to the assumption that the nucleon mass is large compared to the kinetic energy in the center-of-mass system. An essential complication which is now encountered is the appearance of an infrared divergence. Two methods of circumventing this difficulty are discussed. The cross section can be calculated from the Green's function by a limiting process; the usual S-matrix formalism leads to incorrect results in this case, and an amplitude renormalization is required. In this connection, it is instructive to re-examine, in detail, the Coulomb-scattering problem in momentum space, since this is very closely related to the Bethe-Salpeter scattering problem. The Green's-function method turns out to be unsuitable for the calculation of higher-order corrections to the nucleon-nucleon scattering cross section, so that here a cutoff procedure must be used. (auth)

**11029**

RANGE OF 1–10 kev ELECTRONS IN SOLIDS. Charles Feldman (U. S. Naval Research Lab., Washington, D. C.). Phys. Rev. 117, 455-9(1960) Jan. 15.

The range of 1 to 10 kev electrons in metals and phosphors was measured by recording the light output as a function of energy from a sample consisting of a metallic layer deposited on a transparent phosphor layer. The measurements lead to the development of the following range-energy expression: $R = 250(A/\rho Z^{n/2})E^n$, where $n = 1.2/(1-0.29 \log_{10}Z)$, E = energy in kev, R = range in angstroms, and A, $\rho$, Z, have their customary meaning. This differs from the usual range expression in the dependency of n on Z. Usually n is assumed to be independent of material. This dependency can be justified on the basis of Bethe's theory of electron stopping power. (auth)

**11030**

ALPHA–ALPHA SCATTERING IN THE ENERGY RANGE 5 TO 9 MEV. C. M. Jones, G. C. Phillips, and Philip D. Miller (Rice Inst., Houston, Tex.). Phys. Rev. 117, 525-30 (1960) Jan. 15.

The scattering of alpha particles from helium was experimentally studied in the energy range 5 to 9 Mev by the measurement of three excitation functions at the center-of-mass angles 30° 33′, 54° 44′, and 70° 7′. A phase-shift analysis was performed which indicates that only the S- and D-wave phase shifts are necessary to fit the data in this energy region. Only the well-known D state at approximately 2.9 Mev in $Be^8$ was observed. The D state was compared to the single-level dispersion theory and level parameters were extracted which are compatible with the alpha-particle model of $Be^8$. (auth)

**11031**

PHOTOPRODUCTION OF NEUTRAL PIONS AT ENERGIES 600 TO 800 MEV. R. M. Worlock (California Inst. of Tech., Pasadena). Phys. Rev. 117, 537-43(1960) Jan. 15.

The photoproduction of neutral $\pi$ mesons from hydrogen was studied at the California Institute of Technology Synchrotron Laboratory by detecting recoil protons from a liquid hydrogen target irradiated by the synchrotron bremsstrahlung beam. The recoil protons were detected by a five-counter telescope. Data were taken at proton laboratory angles of 19, 30, 40, 50, and 60° at proton energies corresponding to photon energies of 600, 700, and 800 Mev. Angular distribution data are produced at these three energies and fitted with functions of the form: $A + B \cos\theta_\pi' + C \cos^2\theta_\pi'$. These functions are qualitatively like those at lower energies; B is small and $-A/C$ is roughly 1.25. The total cross section is found to have a minimum at about 600 Mev, being slightly larger at 700 and 800 Mev. (auth)

**11032**

SCATTERING OF 200-Mev POSITRONS BY ELECTRONS. J. A. Poirier, D. M. Bernstein, and Jerome Pine (Stanford Univ., Calif.). Phys. Rev. 117, 557-65(1960) Jan. 15.

Scattering of positrons by electrons was investigated by bombarding a beryllium target with 200-Mev positrons and observing the recoil electrons in a diffusion cloud chamber located behind the target. The cloud chamber was in a magnetic field which permitted the yield of recoil electrons to be measured as a function of their energy W. The experiment covered the range $88 \leq W \leq 200$ Mev. The positron beam also traversed the cloud chamber and the total number of incident positrons was determined by track-counting. The total electron yield for $88 \leq W \leq 200$ Mev is (113 ± 9)% below that predicted by the first-order Bhabha theory. This difference cannot be interpreted until radiative corrections to the theory are evaluated. A calculation of these corrections which is valid for the conditions of this experiment is not available. The shape of the electron energy spectrum is in good agreement with the Bhabha theory, and inconsistent with the theory if annihilation terms are omitted. (auth)

**11033**

POSITIVE PION SCATTERING FROM HYDROGEN AT 24.8 MEV. Douglas Miller and James Ring (Univ. of Rochester, N. Y.). Phys. Rev. 117, 582-4(1960) Jan. 15.

An angular distribution for the process $\pi^+ + p \rightarrow \pi^+ + p$ was measured at 24.8 Mev by counter techniques. At this energy the S-wave interaction is larger than the P-wave. Differential cross sections at the three center-of-mass angles, 66, 92, and 163.5°, are (0.286 ± 0.028) mb/sterad, (0.458 ± 0.042) mb/sterad, and (0.993 ± 0.120) mb/sterad, respectively. Over 250 hydrogen interactions were observed at each angle. (auth)

**11034**

POSITIVE PION PHOTOPRODUCTION NEAR THRESHOLD. G. Jona-Lasinio and H. Munczek (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Phys. Rev. 117, 585-9(1960) Jan. 15.

An investigation is made in order to test the compatibility of photoproduction data on positive pions near threshold with some predictions of dispersion theory. The result is that no real disagreement necessarily exists between these theoretical predictions and our still uncertain experimental knowledge. (auth)

**11035**

MASS SPLITTINGS WITHIN BARYON CHARGE MULTIPLETS. R. E. Behrends and L. Landovitz (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 117, 589-94(1960) Jan. 15.

Calculations were made of the effect upon the mass splittings within each isobaric multiplet of a phenomenological boson mass difference. It was possible to sum the diagrams to all orders in the strong couplings but the results are only valid to first order in the mass difference. These results can be compactly expressed as derivatives with respect to the intermediate masses of a function related to the proper self energy. The second-order perturbation results are calculated. (auth)

**11036**

ON THE CLASSIFICATION OF ELECTRON STREAMS. J. D. Lawson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. C, Plasma Phys.—Accelerators—Thermonuclear Research 1, 31-5 (1960) Oct.

The relationships between different types of electron streams may conveniently be studied in terms of three dimensionless characteristic parameters. These are f, the ratio of positive to negative charge in the stream, $\nu$, the product of the number of electrons per unit length in the stream and the classical electron radius $(e^2/mc^2)$, and $\epsilon$ defined as $(1-\beta^2)^{-1/2} - 1$, where $\beta c$ is the drift velocity. With the aid of these parameters a number of typical streams in which f is zero (electron beams in vacuum tubes and accelerators) or unity (neutralized electron beams, Budker's self-constricted beam, pinched gas discharge plasmas) are studied, and relationships between them are illustrated on the log $\epsilon$ − log $\nu$ plane. (auth)

**11037**
POLARIZATION OF CONVERSION ELECTRONS FOLLOWING BETA DECAY. H. R. Lewis and J. R. Albers (Universität, Heidelberg, Ger.). Z. Physik 158, 155-71 (1960). (In English)

Formulas for the partially transverse polarization of the conversion electrons emitted after $\beta$ decay are derived in dependence on the angle between $\beta$ particles and conversion electrons. The dependence of the components of the polarization from the conversion process is expressed by radial integrals and spin-dependent factors. These factors for permitted $\beta$ decay and K and L conversion electrons are tabulated as a function of the multipolarity of the conversion electrons. (tr-auth)

**11038**
DEUTERON PHOTOFISSION AT LOW ENERGIES. Gustav Kramer and Dieter Müller (Universität, Heidelberg, Ger.). Z. Physik 158, 204-13(1960). (In German)

Low-energy photodisintegration of the deuteron is useful for obtaining information about mesonic corrections to the magnetic dipole operator. Therefore, on the basis of a phenomenological theory of the photodisintegration process, the differential cross section and the polarization of the final-state nucleons are calculated. The D-state admixture of the ground state is taken into account. Using information from neutron-proton scattering, the dependence of the magnetic dipole transition on the force parameters is investigated in detail. (auth)

**11039**
DIFFRACTION OF ELECTROMAGNETIC WAVES BY PARABOLOID-SCREEN OF FINITE DIMENSIONS (AXIS-SYMMETRIC FIELDS). Yu. N. Kuzmin (Inst. of Physics and Tech., Academy of Sciences, USSR). Zhur. Tekh. Fiz. 29, 1304-11(1959) Nov. (In Russian)

A mathematical analysis is made of axially symmetric electromagnetic wave diffraction in ideally conducting paraboloidal segments. The solution derived for two types of excitation fields converges into a sequence of electrostatic problems and is expressed by small increments of expansion $\delta = kR$. (R.V.J.)

**11040**
DIFFRACTION OF PLANE ELECTROMAGNETIC WAVE DUE TO IDEALLY CONDUCTING ROUND DISK. K. A. Lur'è (Inst. of Physics and Tech., Academy of Sciences, USSR). Zhur. Tekh. Fiz. 29, 1421-33(1959) Dec. (In Russian)

A solution for plane electromagnetic wave diffraction by ideally conducting disks was derived. The current density in the disk, the wave fields, and the scattering factor are expressed by auxiliary functions satisfying the Fredholm equations of the second type. (tr-auth)

**11041**
ON THE SPATIAL RESONANCE IN SPIRAL WAVEGUIDE PLACED IN MAGNETODIELECTRICAL MEDIUM. V. P. Shestopalov and B. V. Kondratev (Gor'kiĭ Khar'kov State Univ., USSR). Zhur. Tekh. Fiz. 29, 1434-56(1959) Dec. (In Russian)

Dispersion equations were derived for a spiral waveguide placed in a magneto-electrical medium and the conditions of spatial resonance appearance are analyzed. Attenuations in $\beta_0^{\pm}$ and $\beta_n^{\pm}$ as functions of frequency at various values of $\epsilon$ and $\mu$ were analyzed. (tr-auth)

**11042**
ON THE CHARACTERISTICS OF IRRADIATION OF IDEALLY-CONDUCTING SPHERE PLACED IN NON-UNIFORM MEDIUM. Yu. S. Sayaasov (Inst. of Chemical Physics, Moscow). Zhur. Tekh. Fiz. 29, 1486-9(1959) Dec. (In Russian)

Studies were made of a system consisting of an ideally conducting sphere in a heterogeneous medium with a dielectric penetrability factor $\epsilon = \epsilon' + i\epsilon''$ depending only on the radius. (R.V.J.)

## Nuclear Properties and Reactions

**11043** AD-217590
Ohio State Univ., Columbus.
UTILIZATION OF THIN LENS AND SEMICIRCULAR SPECTROMETERS FOR BETA DECAY STUDIES AND THE BETA SPECTRUM OF COBALT-56 (thesis). Donald C. Glenn. 1959. 50p.

Research is reported on detection of the electrino (Ivanenko and Kolesnikov, 1952) by two magnetic spectrometers and on the beta spectrum of $Co^{56}$ to confirm inner positron groups. No confirmation was found. The most energetic positron group had an upper limit of 1.480 kev and is a straight line in a Kurie plot. A bending at 0.470 was attributed to $Co^{58}$ present. An inner $\beta$ group was confirmed with an upper energy limit of 220 kev. A second inner $\beta$ group with a 100-kev limit was indicated. Analysis of certain portions of the momentum spectrum of $P^{32}$ to detect the electrino was inconclusive; however, the method used showed some merit. (T.R.H.)

**11044** AERE-R-3209
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
COLLECTED INDEPENDENT FISSION YIELDS FOR THERMAL NEUTRON FISSION OF $U^{233}$, $Pu^{239}$, AND $U^{235}$, 14 MEV NEUTRON FISSION OF $U^{235}$, PILE NEUTRON FISSION OF $U^{238}$, $Th^{232}$, AND $Am^{241}$, AND SPONTANEOUS FISSION OF $Cm^{242}$. I. F. Croall, comp. Jan. 1960. 9p. BIS.

**11045** AFOSR-TR-60-28
Arkansas. Univ., Fayetteville.
ATOMIC SPECTROSCOPIC INVESTIGATION OF NUCLEAR PROPERTIES. R. H. Hughes. Feb. 1960. 20p. Contract AF18(603)-26.

A study of the isotope shifts in the atomic spectra of the medium-weight elements was undertaken. Experimental data were obtained on the isotope shifts in the spectra of strontium, molybdenum, and ruthenium. A correlation between the binding energy of the last pair of neutrons, obtained from mass spectroscopic data, and isotope shifts was determined. The correlation is explained qualitatively in terms of shell energies and the potential energy of nuclear deformation. (auth)

**11046** CF-59-9-61
Oak Ridge National Lab., Tenn.
THE FAST FISSION FACTOR. G. R. Hoke. Sept. 18, 1959. 46p. OTS.

The fast fission factor is defined and the previously used derivation is discussed. To make the development of the formula for the fast fission factor ($\epsilon$) appear more orderly and understandable, the derivation is improved in two steps. The first step is to introduce the notion of two groups of neutrons with energies above and below the $U^{238}$ fission threshold. The second step is to take cognizance of the subthreshold captures. Application to uranium oxide and clad fuels, numerical values of quantities in the formula for $\epsilon$, and geometrical effects are considered. Results of calculations are given. (W.D.M.)

**11047** CF-60-1-56

Oak Ridge National Lab., Tenn.

BURNUP OF BERYLLIUM BY FAST NEUTRON REACTIONS. A. M. Perry. Jan. 20, 1960. 3p. OTS.

The probability that a fission neutron will produce the (n,2n) or the (n,$\alpha$) reaction in Be or BeO is given. The frequency of various events in BeO is also given. (W.L.H.)

**11048** IDO-16571

Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.

CALCULATION OF THE COMPOSITION OF REACTOR-IRRADIATED HEAVY NUCLIDES. R. P. Schuman and R. L. Tromp. Dec. 17, 1959. 80p. Contract AT(10-1)-205. OTS.

Calculations were made of the compositions of reactor-irradiated $Th^{230}$, $Th^{232}$, $U^{233}$, $U^{235}$, $U^{236}$, $U^{238}$, $Pu^{239}$, $Pu^{242}$, and $Cm^{244}$. Pile fluxes with resonance flux per ln E interval equal to $^1/_{12}$ (typical of MTR fuel) or $^1/_{30}$ (typical of MTR beryllium pieces) of the thermal flux were used for the calculations; thermal fluxes of $5 \times 10^{13}$, $2 \times 10^{14}$, and $1 \times 10^{15}$ n/cm$^2$ sec were assumed. Calculation methods, assumptions concerning cross sections, and possible methods of producing specific nuclides are discussed. (auth)

**11049** KAPL-M-ECH-3

Knolls Atomic Power Lab., Schenectady, N. Y.

EFFECTIVE THERMAL AND EPITHERMAL FISSION FRAGMENT ABSORPTION CROSS-SECTIONS. E. C. Hansen and C. R. Greenhow. Oct. 1, 1959. 19p. Contract W-31-109-Eng-52. OTS.

Previous results were recalculated eliminating two major assumptions. The assumptions eliminated are: one, that the microscopic thermal absorption cross section, $\sigma_{ff}$(th), is a constant independent of the epithermal to thermal flux ratio, A, and is equal to $\sigma_{ff}$(th) for A equal to zero; and two, the epithermal to thermal flux ratio, A, is independent of burnup. The elimination of these two major assumptions does not so much change the absolute magnitude of the presented values (1), but rather enhances their reliability. The results are found to be conservative in predicting both the thermal and epithermal poisoning by the fission fragments. (auth)

**11050** LA-1552

Los Alamos Scientific Lab., N. Mex.

ANGULAR DISTRIBUTION OF FRAGMENTS FROM NEUTRON-INDUCED FISSION. J. E. Brolley, Jr. and W. C. Dickinson. May 7, 1953. Decl. Feb. 24, 1960. 22p. Contract W-7405-eng-36. OTS.

The angular distribution of fission fragments from the neutron-induced fission of several isotopes was studied. Distributions were observed for thermal neutrons on $U^{233}$ and $U^{235}$, Lady Godiva leakage neutrons on $U^{235}$ and $U^{238}$, and 14 Mev neutrons on $U^{233}$, $U^{235}$, $U^{238}$, $Th^{232}$, and $Np^{237}$. No anisotropy was observed for thermal neutron fission, whereas for Lady Godiva neutrons and 14 Mev neutrons the probability of fission along the axis of the neutron beam was determined to be higher than for fission in the orthogonal direction. (auth)

**11051** LA-2373

Los Alamos Scientific Lab., N. Mex.

MOLYBDENUM CROSS SECTIONS AND THEIR TEMPERATURE DEPENDENCE. Joseph J. Devaney, David Coward, and Ralph E. Anderson. Sept. 1959. 125p. Contract W-7405-Eng-36. OTS.

A Breit-Wigner analysis of the molybdenum isotopes is folded into a Maxwellian velocity distribution and summed with abundance weights to obtain total, scattering, and radiative capture cross sections for normal isotopic molybdenum vs. neutron energy from 0.0253 to 730 ev and for molybdenum temperatures of 0.0253 to 500 ev. (auth)

**11052** NP-8400

Joint Inst. for Nuclear Research, Dubna, U.S.S.R. and Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw.

GAMMA SPEKTR $TU^{165}$. (Gamma Spectrum of $Tm^{165}$). S. Khoinatskiĭ, A. Yasinskiĭ, Ya. Kovnatskiĭ, and G. Lantsman. Nov. 1959. 8p.

The $\gamma$ spectrum of $Tm^{165}$ was investigated with a scintillation spectrometer with a 100-channel pulse-analyzer. The $\gamma$ transitions 243, 292, 352, 453, 810, 1172, and 1398 kev observed previously by other authors were confirmed. A new line 2007 kev was found and the relative intensities of lines 1172 : 1398 : 2007 kev = 1: 0, 23 : 0, 06 were estimated. (auth)

**11053** NP-8488

Weizmann Inst. of Science, Rohovoth, Israel.

ON CONFIGURATION INTERACTION IN $Zr^{90}$. Technical (Scientific) Note No. 2. I. Talmi and I. Unna. Jan. 11, 1960. 22p. Contract AF61(052)-56.

Energy levels and wave functions in $Zr^{90}$ and neighboring nuclei are calculated in the framework of the shell model. Theoretical parameters are determined from the data and reproduce a larger number of experimental energy spacings. The configuration admixture in the $Zr^{90}$ ground state obtained is in agreement with the rough experimental findings. (auth)

**11054** ORNL-2823

Oak Ridge National Lab., Tenn.

EFFECTIVE CADMIUM CUTOFF ENERGIES. R. W. Stoughton, J. Halperin, and Marjorie P. Lietzke. Mar. 11, 1960. 34p. Contract W-7405-eng-26. OTS.

Effective cutoff energies for point 1/v absorbers inside of spherical and cylindrical cadmium filters have been calculated for thermal reactor neutrons. The neutron spectrum was assumed to consist of a Maxwellian plus a 1/E component, and the parameters varied were the thickness of filter, the Maxwellian temperature and the Maxwellian to 1/E flux ratio. Because of the sensitivity of the effective cutoff to Maxwellian flux parameters for thin filters it is recommended that filter thicknesses of about 40 mils be used. Forty mil filters show effective cutoffs at about 0.50 to 0.55 ev for temperatures up to about 500°A (or about 0.045 ev). Effective cutoff energies for boron filters were also calculated for purposes of comparison. The cutoffs for cylindrical cadmium filters should be applicable to a properly designed experimental facility. (auth)

**11055** TID-5642

Washington Univ., St. Louis.

INTERACTIONS OF FAST $\mu$-MESONS IN LEAD WITH SMALL ENERGY TRANSFER. Technical Report No. 5. J. dePagter and R. D. Sard. Jan. 1960. 48p. Sponsored by ONR and AEC under contract NONR-816. OTS.

With the Pb target material divided into 1.27 cm slabs between hodoscoped Geiger tubes and surmounted by a magnet cloud chamber, a study was made of the interactions of fast $\mu$-mesons in which at least one evaporation neutron is produced and no additional charged particles emerge from the slab. The cross section average neutron multiplicity, $\overline{\sigma m}$, is $(15.2 \pm 2.1) \times 10^{-29}$ cm$^2$ per nucleon. From hodoscope observations without neutron coincidence it is found that for an electron-initiated shower to stay concealed in a 1.27 cm Pb plate its energy must be less than about 100 Mev. With the help of "approximation B" track length theory and experimental photonuclear neutron yields, it is calculated that hidden knock-on showers contribute $(5.8 \pm 1.2) \times 10^{-29}$ to the total $\sigma\overline{m}$, leaving $(9.4 \pm 2.4) \times 10^{-29}$ cm$^2$ per nucleon as the result for the direct $\mu$ meson nuclear interaction. This analysis is supported by the agreement between the number of visible showers observed and calculated. The neutron yield in the direct interaction is found to increase with $\mu$-meson momentum. The Weizsaecker-Williams approximation is used to calculate the effect expected from the interaction between the electric charge of the $\mu$-meson and the nucleons. Within the rather large uncertainties involved in the use of this approximation, there is excellent agreement with the experimental results. (auth)

**11056** TID-7571(p.1-7)
Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.
FUNDAMENTALS OF RADIOACTIVITY. R. T. Overman. 7p.

Originally published as NUCLEAR STRUCTURE AND NUCLEAR REACTIONS in Florida Eng. and Ind. Exp. Sta. Bull. Ser. No. 48, (1951) Nov.

Fundamentals of nuclear structure and nuclear reactions are reviewed. (C.H.)

**11057** TNCC(UK)-43
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE MOST RECENT VALUES OF $\bar{\nu}$ FOR A NUMBER OF FISSILE ISOTOPES MEASURED USING THE BORON PILE. D. W. Colvin and M. G. Sowerby. Aug. 1959. 6p.

The most recent values of the average number of neutrons per fission determined by the Boron Pile are given. Isotopes included $U^{233}$, $Pu^{239}$, $Pu^{240}$, $Cf^{252}$, and $U^{235}$. (W.D.M.)

**11058** TNCC(UK)-44
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
NEUTRON WIDTHS OF RESONANCES IN $U^{238}$ UP TO 2 Kev. F. W. K. Firk, J. E. Lynn, and M. C. Moxon. Aug. 1959. 15p.

The neutron widths of 70 resonances in $U^{238}$ were determined by the transmission method assuming a constant radiation width of 25 Mev. Using the Harwell 15 Mev linear accelerator and time-of-flight spectrometer with a resolution of 0.0025 $\mu$sec/m, it was possible to carry out measurements up to 2 kev. The neutron strength function in this energy range is found to be $(1.07 \pm 0.15) \times 10^{-4}$. This value is 13% higher than that obtained by workers at Columbia University using "self-indication" techniques. The small resonances for which we have no results have a negligible effect on the value of the strength function. There is good agreement between the present value of the strength function and the Brookhaven value of $(1.1 \pm 0.2) \times 10^{-4}$ obtained from the average total cross section in the kev region. (auth)

**11059** UCRL-9031
California. Univ., Berkeley. Lawrence Radiation Lab.
REMARKS ON PROPERTIES OF EVEN-EVEN NUCLEI RELATED TO THE ASYMMETRIC ROTOR THEORY OF DAVYDOV AND FILIPPOV. Horacio E. Bosch. Feb. 1960. 17p. Contract W-7405-eng-48. OTS.

Some remarks concerning the relation of the predictions of the Davydov and Filippov asymmetric rotor theory to the experimental data are pointed out. The different ratios of the energy of the excited states as a function of the gamma parameter and the reduced electric-quadrupole transition ratios as a function of the gamma parameter are discussed. A brief summary of the nuclei which do not fall in the general picture predicted by the mentioned theory is given. (auth)

**11060** USNRDL-TR-359
Naval Radiological Defense Lab., San Francisco.
EARLY TIME DECAY OF FISSION PRODUCT MIXTURES. I. SCINTILLATION COUNTER MEASUREMENTS FOLLOWING THERMAL NEUTRON FISSION OF $U^{235}$. J. L. Mackin, P. E. Zigman, P. O. Strom, and M. J. Nuckolls. Aug. 10, 1959. 19p.

Photon decay rates of fission product mixtures from thermal neutron fission of $U^{235}$ were measured for times after fission of one second to several hours with a well-type scintillation detector (counter). These data may be used as a reference base for decay measurements of fallout made with the same or similar instruments. The measured decay values were compared with recently reported experimental determinations of photon decay. This comparison permitted estimates of the numbers of photons (photon release rates) in the photon energy region below 0.3 Mev. (auth)

**11061** USNRDL-TR-400
Naval Radiological Defense Lab., San Francisco.
EARLY TIME DECAY OF FISSION PRODUCT MIXTURES. II. GAMMA ENERGY RELEASE AND IONIZATION RATES FOLLOWING THERMAL NEUTRON FISSION OF $U^{235}$
P. Zigman and J. Mackin. Feb. 11, 1960. 14p.

Photon spectra at various times from one second to five hours after instantaneous thermal neutron fission of $U^{235}$ are listed. From these spectra are computed total gamma ray energy release rates and theoretical air ionization rates 3 feet above an infinite plane uniformly contaminated with fission products. Equations are given which provide a good fit to the rate curves within the estimated accuracy of the data. Values for accumulated dose are derived. The energy release and ionization decay rates and the integrated doses are compared with those derived from the $t^{-1.2}$ function. (auth)

**11062**
STATISTICAL MODELS FOR HIGH ENERGY NUCLEAR REACTIONS. [PART] I. Maurice Neuman (Univ. of California, Berkeley). Anais acad. brasil. cienc. 31, 361-79 (1960). (In English)

The crude theoretical approach to calculating high-energy nuclear collisions of Fermi is treated. The discussion is largely limited to the central idea expressed in Fermi's assumption that statistical equilibrium consists in postulating that the square of the matrix element is merely proportional to the probability that for a state in question all particles are contained at the same time inside $\underline{v}$. The presentation begins with a Lorentz covariant formulation of the classical theory of the microcanonical ensemble. The quantum mechanical S matrix expression is then examined for a corresponding structure. This leads to what appears to be a covariant version of the Wigner coördinate-momentum distribution function. Thermodynamic approximations at high energies are then discussed. (T.R.H.)

**11063**
ANGULAR CORRELATION MEASUREMENTS ON $Xe^{128}$. I. Asplund and T. Wiedling (Univ. of Stockholm). Arkiv Fysik 16, 219-25(1960). (In English)

The gamma-gamma angular correlation of the two cascaded gamma radiations with energies 0.540 and 0.455 Mev following the negatron decay of $I^{128}$ was studied. The spin sequence of the $Xe^{128}$ states is shown to be $2+$ (0.540 Mev/M1 + E2) $\rightarrow$ $2+$ (0.455 Mev/E2) $\rightarrow$ $0+$ with 2.4% M1 in the

0.540 Mev transition. A weak indication of positrons of an intensity of only 0.002% in the $I^{128}$ to $Te^{128}$ branch was observed. (auth)

**11064**

A MEASUREMENT OF THE LIFETIME OF THE FIRST EXCITED STATE IN $Tl^{200}$. E. Bashandy and J. Lindskog (Univ. of Uppsala). Arkiv Fysik 16, 227-9(1960). (In English)

The lifetime of the 148-kev level in $Tl^{200}$ was determined to be 7.3 ± 0.3 mμs by employing an electron-electron coincidence spectrometer. (C.J.G.)

**11065**

A DETERMINATION OF THE SPINS OF THE 3.47 AND 3.61 MEV LEVELS IN $Zr^{90}$. B. Hartmann and T. Wiedling (Univ. of Stockholm). Arkiv Fysik 16, 285-91(1960). (In English)

The angular correlation of the 142 kev to 1.14 Mev gamma cascade in $Zr^{90}$ was measured. The observed distribution function was found to be $W(\theta) = 1 - (0.063 \pm 0.008)P_2(\cos\theta)$. It is shown that 5, 6, and 8 are the most probable spins of the 2.33, 3.47, and 3.61 Mev levels, respectively. (auth)

**11066**

ON THE NUMBER OF NEUTRONS FROM SOME FISSION FRAGMENTS. V. F. Apalin, Yu. P. Dobrynin, V. P. Zakharova, I. E. Kutikov, and L. A. Mikaelyan. Atomnaya Energ. 8, 15-22(1960) Jan. (In Russian)

The number of neutrons emitted by individual fragments from $U^{235}$ fission by thermal neutrons was measured using a large detector filled with a liquid organic cadmium-containing scintillator. The numbers of prompt neutrons were measured under $4\pi$ geometry conditions as a function of fragment mass. The excitation energy spent on prompt neutrons was derived on the basis of Weizsäcker's semi-empirical formula. A sharp asymmetry was noticed in the distribution of excitation energies between heavy and light fragments. The new data do not agree with the Fong statistical fission theory. (tr-auth)

**11067**

NEW ISOTOPES OF HOLMIUM AND ERBIUM. I. S. Dneprovskii. Atomnaya Energ. 8, 46-7(1960) Jan. (In Russian)

The conversion electron spectra of erbium isotopes produced by bombarding tantalum with 660-Mev protons were investigated. (R.V.J.)

**11068**

$Th^{229}$ MONOCHROMATIC NEUTRON FISSION CROSS-SECTION IN THE ENERGY INTERVAL 0.02–0.8 ev. Yu. Ya. Konakhovich and M. I. Pevzner. Atomnaya Energ. 8, 47-8(1960) Jan. (In Russian)

A crystal spectrometer placed in the horizontal beam of the IRT reactor was used for plotting the $Th^{229}$ fission cross sections at neutron energies of 0.025 to 0.8 ev. Three resonance levels at 0.240, 0.563, and 0.727 ev were observed and analyzed. (R.V.J.)

**11069**

THE FAST NEUTRON AVERAGE NUMBER OF $U^{238}$ IN SPONTANEOUS FISSION. E. K. Gerling and Yu. A. Shukolyukov. Atomnaya Energ. 8, 49(1960) Jan. (In Russian)

It was found that the true $U^{238}$ half-decay period equals $5.8 \times 10^{15}$ years. The mean number of neutrons per spontaneous fission is 1.7, in good agreement with previous calculations which showed $\bar{\nu}_{238} = 1.6$. (R.V.J.)

**11070**

AN ISOTOPE OF ARSENIC WITH A PERIOD OF 33 ± 1 SEC. Christian Ythier. Compt. rend. 250, 1630-1(1960) Feb. 29. (In French)

An activity with a period of 33 ± 1 sec, observed in the decay of arsenic formed by the irradiation of selenium with fast neutrons, is attributed to the decay of a new isotope $As^{81}$. (tr-auth)

**11071**

"BREAK" OF THE ACTIVATION CURVES OF FLUORINE AND NITROGEN BY PHOTONEUTRON REACTION. Dror Sadeh. Compt. rend. 250, 1632-4(1960) Feb. 29. (In French)

With a new system of counting, the threshold and the "breaks" of the activation curves of the reactions $N^{14}(\gamma,n)N^{13}$ and $F^{19}(\gamma,n)F^{18}$ were determined. New "breaks" were found. The counting of the $\beta^+$ activity of $N^{13}$ and $F^{18}$ were done in coincidence with two large NaI(Tl) crystals. (tr-auth)

**11072**

ON THE PROBABILITY OF DOUBLE BETA DECAY. F. Janouch (Moscow State Univ.). Czechoslov. J. Phys. 10, 1-6(1960). (In English)

Double beta decay is discussed in relation to parity non-conservation. Two possible ways of neutrino-less double beta decay (allowed and forbidden) are investigated and the half-life of decay is calculated. For allowed transitions an estimated $T_{1/2} = 2 \times 10^{19}$ years was obtained for $Ca^{48}$. (auth)

**11073**

THE THERMAL NEUTRON ABSORPTION CROSS-SECTION OF $^{233}Th$ AND THE RESONANCE INTEGRALS OF $^{232}Th$, $^{233}Th$, AND $^{59}Co$. F. J. Johnston (Univ. of Louisville, Ky.) and J. Halperin and R. W. Stoughton (Oak Ridge National Lab., Tenn.). J. Nuclear Energy, Pt. A, Reactor Sci. 11, 95-100(1960) Feb. (In English)

The thermal neutron absorption cross-section of $Th^{233}$ and the resonance absorption integrals of $Th^{232}$, $Th^{233}$, and $Co^{59}$ were measured as 1450, 85, 400, and 75 barns, respectively, by neutron activation measurements using cadmium filters with reactor spectrum neutrons. (auth)

**11074**

NEUTRON IRRADIATION OF TRANSITION METALS AT LOW TEMPERATURES. Pierre Lucasson (Laboratoire de Chimie Physique, Paris). J. Nuclear Energy, Pt. A, Reactor Sci. 11, 108-13(1960) Feb. (In French)

Niobium, molybdenum, palladium and tantalum, tungsten, and platinum were irradiated with fast neutrons in an apparatus cooled with liquid nitrogen. The measured increases of electrical resistances show a periodicity which seems to be related to the electronic structure of the metals. (auth)

**11075**

STUDY OF NEUTRONS FROM A Po–F($\alpha$,n) SOURCE. A. J. D. Szilvasi, K. W. Geiger, and W. R. Dixon (National Research Council, Ottawa). J. Nuclear Energy, Pt. A, Reactor Sci. 11, 131-5(1960) Feb. (In English)

The neutron spectrum of a Po–F($\alpha$,n) source was determined with nuclear emulsions. There is a single maximum occurring at about 1.3 Mev, and the maximum neutron energy is about 3 Mev. A study of the gamma rays from excited states in the residual $Na^{22}$ nucleus was made by taking neutron-gamma coincidences. The gamma ray spectrum thus found supports a recently published level scheme for $Na^{22}$. A calculation of the neutron spectrum, under certain simplifying assumptions, shows that this level scheme is compatible with the observed neutron spectrum. (auth)

**11076**

RADIAL DEPENDENCE OF THE DOPPLER EFFECT IN BARS OF URANIUM AND THORIUM. R. M. Pearce (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. A, Reactor Sci. 11, 136-49 (1960) Feb. (In English)

If a lump containing uranium or thorium is heated in a reactor spectrum, the rate of neutron capture changes. This is called the 'Doppler effect'. An experimental investigation shows that uniform heating of a sample of thorium or uranium causes a constant fractional increase in activation per atom throughout the main volume of the sample, upon which is superposed a peak close to, but inside, the surface of the samples. The peak rises above the volume effect by factors of 8 and 3 for uranium and thorium respectively and extends to a depth of 0.2 mm and 1.5 mm in the two cases. It is shown theoretically that this peak in the Doppler effect is due to activation in the resonances below 100 ev from impinging neutrons which have not suffered a potential scattering event. The theory predicts that at large penetrations the Doppler effect in the uncollided flux results in a decrease in activation with increasing temperature i.e. the opposite sign from the peak. When averaged through a thick rod the net contribution of the resonances below 100 ev to the Doppler effect is small. It is predicted that the Doppler effect will be a maximum for uranium lumps 0.2 mm in size, the resonances below 100 ev being responsible for the maximum. An attempt is made to take account of the resonance scattering of the impinging flux. The volume Doppler effect arises mainly from the presence of potential scattering and the unresolved resonances makes the larger contribution. Predictions made by L. Dresner for the temperature dependence of the volume term of the effective resonance integral are consistent with the experimental results at the center of the sample. For 1 in. bars of uranium and thorium, the experimental values of the Doppler coefficient $(1/\bar{I}_+)(d\bar{I}_+/dT)$ are found to be $(0.90 \pm 0.17) \times 10^{-4}$ per °C and $(2.7 \pm 0.1) \times 10^{-4}$ per °C, where $\bar{I}_+$ is the average effective resonance integral including the 1/v-contribution above the cadmium cut-off. (auth)

**11077**

STUDY OF THE DISINTEGRATION OF $Ba^{139}$. Jerzy Jastrzebski (Laboratoire de Physique Nucléaire, Orsay, France). J. phys. radium 21, 12-16(1960) Jan. (In French)

The disintegration of $Ba^{139}$ was investigated by means of a magnetic $\beta$ spectrometer, working in $\beta$-$\gamma$ coincidence, a $\gamma$ spectrometer, and a slow-fast coincidence circuit. Four $\beta$-ray branchings were found with the following maximum energies and log ft: $\beta_1$ (E-2,300 kev; 7.0), $\beta_2$(E-2,140 kev; 7.0), $\beta_3$ (E-1,400 kev; 6.6), and $\beta_4$ (E ~900 kev; ~7). The existence of two new levels of $La^{139}$ was verified by coincidence measurements and the analysis of the $\beta$ spectrum. The half life of 166 kev level was found to be $(1.7 \pm 0.2) \times 10^{-9}$ sec. A level scheme for the disintegration of $Ba^{139}$ is proposed. (auth)

**11078**

STUDY OF THE CONVERSION ELECTRONS AND K AND L AUGER ELECTRONS OF THE $Tm^{170}-Yb^{170}$ DISINTEGRATION. P. Marguin and M. A. Moussa (Institut de Physique Nucléaire, Lyon). J. phys. radium 21, 17-23(1960) Jan. (In French)

The spectra of internal conversion electrons and Auger K and L electrons from radioactive decay of $Tm^{170}$ were studied with an iron-free double-focusing spectrometer and uniform thin sources. The ratios K|L, L|M, and $L_I|L_{II}|L_{III}$ were determined and also the intensity ratios of Auger electrons KLX|KLL. The method of postacceleration of electrons permitted study of Auger L electrons. (auth)

**11079**

THREE NEW ISOTOPES, $Co^{63}$, $Ga^{75}$, AND $As^{81}$. Haruhiko Morinaga, Tokihiro Kuroyanagi, Hidehiko Mitsui, and Katsufusa Shoda (Tohoku Univ., Sendai). J. Phys. Soc. Japan 15, 213-17(1960) Feb. (In English)

Three previously unknown isotopes, $Co^{63}$, $Ga^{75}$, and $As^{81}$ were identified from the $(\gamma,p)$ reactions on natural nickel, germanium, and selenium. Their radiations were investigated with the aid of scintillation spectrometers. Decay characteristics are presented. (auth)

**11080**

FINE STRUCTURE IN THE $N^{14}(\gamma,n)N^{13}$ ACTIVATION CURVE. II. Naoshi Mutsuro, Kazuo Sato, and Masanori Mishina (Tohoku Univ., Sendai). J. Phys. Soc. Japan 15, 358(1960) Feb. (In English)

In previous study of the activation curve for the $N^{14}(\gamma,n)N^{13}$ reaction, eight breaks in the 11 to 17 Mev energy region were reported. The energy region was extended from 14.70 to 19.50 Mev, and three additional breaks were observed. The significance of the breaks for these energy regions is discussed. (B.O.G.)

**11081**

DIFFERENTIAL CROSS SECTIONS FOR THE $N^{14}(d,p)N^{15}$ GROUND STATE REACTION AT THE DEUTERON ENERGY OF 16 MEV. Susumu Morita, Nawoyuki Kawai, Naoyuki Takano, Yorio Gotô, and Reiko Hanada (Kyushu Univ., Fukuoka); Yutaka Nakajima (Univ. of Tokyo); and Shigeo Takemoto and Yûki Yaegashi (Tohoku Univ., Sendai). J. Phys. Soc. Japan 15, 361-2(1960) Feb. (In English)

Presented are the results of preliminary measurements of the change of angular distribution with deuteron energy in the $N^{14}(d,p)N^{15}$ ground state reaction. Comparison was made with values for the $C^{12}(\alpha,p)N^{15}$ reaction obtained by Nonaka et al., with the energies of alpha particles corresponding to nearly the same excitation energies of the compound nucleus $O^{16}$ as those for the $N^{14}(d,p)N^{15}$ reaction. A continuation of this study is being made at a more extensive deuteron energy range. (B.O.G.)

**11082**

LOWER EXCITED STATES IN $P^{29}$. Tatsuo Tabata, Hisae Fukuda, and Kotoyuki Okano (Kyoto Univ.). J. Phys. Soc. Japan 15, 364-5(1960) Feb. (In English)

Investigations were made of $\gamma$ rays from the $Si^{28}(p,\gamma)P^{29}$ reaction at the $E_p$ = 367 kev resonance, corresponding to the 3.12-Mev level in $P^{29}$, which has been reported to decay mainly to the first and second excited states in $P^{29}$. Level schemes of the mirror pair $P^{29}-Si^{29}$ are given. (B.O.G.)

**11083**

MANY-BODY BASIS FOR THE OPTICAL MODEL. Lee M. Frantz and Robert L. Mills (Ohio State Univ., Columbus). Nuclear Phys. 15, 16-32(1960) Feb. (1) (In English)

A formal expression is derived for an optical model potential based on an assumed two-body interaction between nucleons, which provides an exact description of the elastic scattering of a single nucleon by a closed shell (or closed shell ±1) nucleus. A second-quantized description is used for the many-fermion system, the true state vector being expanded in terms of a complete set of single-particle model wave functions. Elimination of the variables of all but the scattered nucleon yields a weighting function which satisfies a one-body Schrödinger equation, whose S-matrix elements are identical with those of the true S-matrix between states corresponding to elastic scattering. The effective optical model potential is identified from this Schrödinger equation, and is found to be complex and nonlocal. It contains all the effects of the exclusion principle, and is in the form of a linked-cluster perturbation expansion, so that the spurious divergence of Brillouin-Wigner perturbation theory for a large number of nucleons is absent. (auth)

**11084**

ON THE EXISTENCE OF OCTUPOLE VIBRATIONS IN NUCLEI. A. M. Lane (Atomic Energy Research Establishment, Harwell, Berks, Eng.) and E. D. Pendlebury (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nuclear Phys. 15, 39-55(1960) Feb. (1) (In English)

It is shown that several different kinds of experimental data point to the existence of octupole vibrations in nuclei. These occur at an excitation energy of about 2.5 to 3 Mev in most nuclei, and rather higher in the light nuclei. Some detailed theoretical interpretation is made of (1) the observed E3 lifetimes, which are interpreted in terms of sum-rules, and (2) the constancy of the octupole excitation energy which is in marked contrast to the well-known peaking in the quadrupole energy near closed shells. Attention is drawn to several kinds of experiment that may give useful further evidence. (auth)

**11085**

DEUTERON PHOTODISINTEGRATION AND P-WAVE PHASE SHIFTS IN THE MEDIUM ENERGY RANGE. Gustav Kramer (Universität, Heidelberg, Ger.). Nuclear Phys. 15, 60-71(1960) Feb. (1) (In English)

The angular distribution and the parameter of the polarization of nucleons produced in deuteron photodisintegration are calculated for different phase shift sets which fit n−p scattering data corresponding to 40 Mev, 100 Mev, and 150 Mev in the laboratory system. It is found that all the sets which are characterized by positive $^3P_0$ and negative $^3P_1$ phase shifts give similar results for the angular distribution. A small polarization results from sets with a large $^3P_0$ phase shift. For all of the sets which are characterized by a negative $^3P_0$ and a positive $^3P_1$ phase shift we obtain angular distributions which are outside the experimental errors, if one assumes that the D-state probability of the ground state is not extremely large. (auth)

**11086**

RELATION BETWEEN ANGULAR DISTRIBUTION AND POLARIZATION IN THE OPTICAL MODEL. Leonard S. Rodberg (Los Alamos Scientific Lab., N. Mex.). Nuclear Phys. 15, 72-8(1960) Feb. (1) (In English)

The relation between the angular dependence of the cross section and the polarization is discussed. A formula is derived for estimating the depth of the spin-orbit potential from the observed polarization. Sufficient conditions for the validity of these results are derived. In the course of this discussion a useful approximate formula is derived which relates the depth of the central potential, the size of the target, and the positions of the minima in the angular distribution. (auth)

**11087**

SEARCH FOR PSEUDOSCALAR INTERACTION IN BETA-DECAY. S. G. Cohen and R. Wiener (Hebrew Univ., Jerusalem). Nuclear Phys. 15, 79-88(1960) Feb. (1) (In English)

The degrees of longitudinal polarization of high energy monoenergetic electrons from $Pr^{144}$ and $Rh^{106}$ were compared by measuring the circular polarization of external bremsstrahlung produced by these electrons when stopped in lead. By using conventional $\beta$-decay theory the upper limit for $|X| = |C_P\int\beta\gamma_5/C_A\int\sigma_r|$ of the $Pr^{144}$ $0^- \rightarrow 0^+$ transition was determined to be 0.08. Making special assumptions regarding the pseudoscalar matrix element, this leads to $|C_P/C_A| \leqq 20$. (auth)

**11088**

$\beta$-DECAY OF $Re^{188}$. R. G. Arns, R. D. Riggs, and M. L. Wiedenbeck (Univ. of Michigan, Ann Arbor). Nuclear Phys. 15, 125-33(1960) Feb. (1) (In English)

The gamma rays in $Os^{188}$ following beta decay of 18-h $Re^{188}$ were studied using coincidence and directional correlation techniques. The results agree with the principal features of the decay scheme proposed by Johns et al. A number of new, weak transitions are observed and an additional level is proposed at 1.750 Mev. Directional correlation measurements were made on six cascades. From the directional correlation measurements, spins 2, 2, 0, 2, 0, 2 are assigned to the levels at 0.155 Mev, 0.633 Mev, 1.086 Mev, 1.461 Mev, 1.765 Mev, and 1.941 Mev, respectively. The 0.478-Mev gamma ray is a dipole-quadrupole mixture with $Q \leqq 99\%$. The 0.828-Mev and 1.308-Mev gamma rays are pure dipole. (auth)

**11089**

INELASTIC SCATTERING FROM ODD-MASS RARE EARTHS. M. C. Olesen and B. Elbek (Univ. of Copenhagen). Nuclear Phys. 15, 134-42(1960) Feb. (1) (In English)

The reduced electric quadrupole transition probabilities and excitation energies of the accessible low lying states in $Eu^{151}$, $Eu^{153}$, $Tb^{159}$, $Ho^{165}$, $Er^{167}$, and $Tm^{169}$ were measured by Coulomb excitation with protons or deuterons having an initial energy of about 4.5 Mev. The measurements were performed on the groups of inelastically scattered particles by means of a magnetic spectrograph, a method particularly suited for the determination of the absolute transition probability. The results are discussed in terms of the rotational model. (auth)

**11090**

A NUCLEAR REACTION OF THE TYPE ($\alpha$, $\alpha$ + 3n). Wolfgang Riezler (Universität, Bonn). Nuclear Phys. 15, 143-5(1960) Feb. (1) (In German)

If cesium is irradiated with alpha-particles, at energies higher than about 55 Mev, $Cs^{130}$ is formed. From a calculation of the reaction energies involved it follows that the reaction is ($\alpha$, $\alpha$ + 3n). It is suggested that the alpha-particle behaves inside the struck nucleus as a cluster, which is emitted again, before all its kinetic energy is distributed to form a compound nucleus. (auth)

**11091**

MEASUREMENTS OF THE FLUORESCENT YIELD OF THE K-SHELL WITH A PROPORTIONAL COUNTER. H. L. Hagedoorn and A. H. Wapstra (Technische Hogeschool, Delft, Netherlands). Nuclear Phys. 15, 146-51 (1960) Feb. (1) (In English)

Using a proportional counter in coincidence with a scintillation spectrometer, fluorescent yields in the K-shell were determined from measurements on nuclei decaying by electron capture. A new set of constants in the semi-empirical formula giving the relation between $\omega_K$ and Z was derived from these results in combination with earlier data. (auth)

**11092**

ANGULAR DISTRIBUTION OF FRAGMENTS FROM FISSION OF URANIUM INDUCED BY 185-Mev PROTONS. U. L. Vallinder and H. Tyrén (Univ. of Uppsala). Nuclear Phys. 15, 152-4(1960) Feb. (1) (In English)

Protons of 185 Mev were used to study the angular distribution of the total fission products from natural uranium. The distribution is found to have an anisotropy of $-0.09 \pm 0.05$. (auth)

**11093**

SCATTERING OF 14.6 Mev NEUTRONS BY Mg, Ca, Cd, Ta, AND Bi. W. G. Cross and R. G. Jarvis (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nuclear Phys. 15, 155-65(1960) Feb. (1) (In English)

Differential cross-sections for 14.6-Mev neutrons scattered elastically from Mg, Ca, Cd, and Bi were measured at 25 angles between 8° and 130° and from Ta at angles out to 80°. A neutron beam was defined by counting only neutrons in delayed coincidence with a collimated beam of alpha particles from the $T(d, n)He^4$ reaction. The neutron detector bias was set to reject neutrons below 10.5 Mev. The results are corrected for angular resolution (± 3°) and for absorption and multiple scattering in the thin (0.05 to 0.1 MFP) cylindrical scatterer. The results were compared by several authors with optical model calculations. (auth)

**11094**

MEASUREMENT OF g-FACTORS OF SEVERAL SHORT LIVED NUCLEAR STATES IN ODD-MASS NUCLEI. G. Manning and J. D. Rogers (California Inst. of Tech., Pasadena). Nuclear Phys. 15, 166-86(1960) Feb. (1) (In English)

The g-factors of several excited states were measured by observing the rotation of the angular correlation of $\gamma-\gamma$ cascades by an applied magnetic field. The results are: 280-kev state of $As^{75}$($\tau = 3.4 \times 10^{-10}$ sec) $g = 0.42 \pm 0.13$, 114-kev state of $Lu^{175}$ ($\tau = 9.4 \times 10^{-11}$ sec) $g = 0.5 \pm 0.2$, and 113-kev state of $Hf^{177}$ ($\tau = 6 \times 10^{-10}$ sec) $g = 0.22 \pm 0.06$. These results are compared with the theoretical predictions of the Nilsson model and are in good agreement. For the case of $As^{75}$ other relevant properties are also compared with the model predictions. The results indicate that the model can be usefully applied to $As^{75}$ and that the nucleus has a prolate deformation ($\eta \approx 2.5$). The g-factor of the 91-kev level of $Pm^{147}$ was studied, a definite rotation of the angular correlation being observed. Computation of the g-factor from the observed data is uncertain because the time dependent attenuation of the $\gamma-\gamma$ correlation is not known. The results are $g = (0.9 \pm 0.2)/G_2$. The effect of the paramagnetic nature of the rare earth ions on such measurements on this group of nuclei is discussed as an appendix. Other assumptions made in deducing the g-factors from the observed rotations of the angular correlations are discussed. (auth)

**11095**

PROTON AND ANTIPROTON DIFFRACTION SCATTERING ON COMPLEX NUCLEI. G. Baroni, G. Bellettini, C. Castagnoli, M. Ferro-Luzzi, and A. Manfredini (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo cimento (10) 15, 1-6(1960) Jan. 1. (In English)

A comparison of the results on antiproton and proton diffraction scattering on emulsion nuclei is carried out on the basis of 26.4 m proton track with $\bar{E} = 125$ Mev, and 23.15 m of antiproton track with $\bar{E} = 150$ Mev. A disagreement is shown to exist between experiment and optical model calculations at 140 Mev. (auth)

**11096**

A METHOD TO DETERMINE THE CHARGE OF NUCLEI WITH NUCLEAR EMULSIONS. G. Alvial, L. Grimaldi, J. Riquelme, E. Silva, and S. Stantic (Universidad de Chile, Santiago). Nuovo cimento (10) 15, 25-30(1960) Jan. 1. (In English)

First experimental results are given on a method to determine the charge of either high or low energy nuclei with nuclear emulsions. Only the track thicknesses were considered over a pre-fixed width obtained by measuring the thickness according to the method given by Occhialini and collaborators and determined a criterion to count this type of thickness which are probably caused by little δ-rays. (auth)

**11097**

MEASUREMENT OF THE TOTAL, DIFFERENTIAL, AND EXCHANGE CROSS SECTIONS FOR THE SCATTERING OF LOW-ENERGY ELECTRONS BY POTASSIUM. Kenneth Rubin, Julius Perel, and Benjamin Bederson (New York Univ.). Phys. Rev. 117, 151-8(1960) Jan. 1.

An atom beam recoil technique was used to determine the total, Q, differential, $\sigma(\theta)$, and differential exchange, $\sigma_e(\theta)$, cross sections for the scattering of low-energy electrons by potassium. The method consists of observing the angular distribution of atoms scattered from a potassium atom beam which was cross fired by an electron beam. Relative values of $\sigma(\theta)$ are then obtained by transforming to electron scattering angles. An inhomogeneous magnet and collimating channel are used as a velocity filter for the atom beam. Curves representing the variation of $\sigma(\theta)$ with $\theta$ between approximately 15° and 60° are presented for various electron energies between 0.6 and 9.0 ev. The magnet also serves to polarize the beam. Relative values of $\sigma_e(\theta)$ were determined by observing the amount of depolarization of the beam in the scattering region, using a second inhomogeneous magnet as an analyzer. Over the observed range of angles, exchange accounts for approximately one third of the scattering. Bounds on the total exchange cross section, $Q_e$, are also tabulated for energies between 0.5 and 4.0 ev. The bounds on $Q_e$ at 0.5 volt are $0.8 \times 10^{-14}$ cm$^2$ $< Q_e < 1.6 \times 10^{-14}$ cm$^2$. (auth)

**11098**

HARMONIC OSCILLATOR WAVE FUNCTIONS IN NUCLEAR SPECTROSCOPY. R. D. Lawson (Univ. of Chicago) and M. Goeppert-Mayer (Argonne National Lab., Lemont, Ill. and Univ. of Chicago). Phys. Rev. 117, 174-84(1960) Jan. 1.

Pairing energy calculations are generally carried out assuming the nucleon wave functions are those of an harmonic oscillator. The two-body interaction is assumed to be some function of $\sigma_1$, $\sigma_2$, and $r_1-r_2$. Since the coordinates appear only in the form $r_1-r_2$, it is convenient to write the two-body wave function in terms of the relative coordinate, $r = r_1-r_2$, and the center-of-mass coordinate, $2R = r_1 + r_2$. The eigenfunction in the new coordinates can be determined by noting that if the two particles are in the same oscillator level, then $\psi(r_1,r_2)$, which is an eigenfunction of $H_1 + H_2$, is also an eigenfunction of $H_1$ alone. Transforming $H_1$ to relative and center-of-mass coordinates implies that the operator $p \cdot P + mkr \cdot R$ (where m is the mass of the particle and k is the spring constant of the oscillator) must give zero when operating on the wave function. This condition plus certain requirements arising from the radial form of the oscillator eigenfunctions is sufficient to determine the wave function in the new coordinate system. (auth)

**11099**

SEARCH FOR PSEUDOSCALAR INTERACTION IN $\frac{1}{2}+ \rightarrow \frac{1}{2}-\beta$-DECAY TRANSITION. S. Cuperman (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. 117, 185-6(1960) Jan. 1.

The longitudinal polarization of the electrons emitted by $_{81}Tl^{207}$ ($\frac{1}{2}+ \rightarrow \frac{1}{2}-$) was measured by double Coulomb scattering. Within the experimental error, a $-v/c$ polarization was obtained. In order to deduce the amount of pseudoscalar contributions, one must know the other nuclear matrix elements. They were taken from a theoretical shell-model calculation and a j–j coupling single-particle model. Assuming $C_S = C_T = 0$, two-component neutrino theory [which predicts opposite polarization in the case of (V,A) and P interactions], left-handed neutrino, and time-reversal invariance, as well as a surface distribution of the nuclear charge, one finds $|x|^2 \leq 4.4 \times 10^{-2}$ (if $C_P/C_A > 0$), with $x = -i(C_P/C_A)[\int\beta\gamma_5/\int\sigma \cdot r]\rho$ ($\rho$ being the nuclear radius). (auth)

**11100**

CALORIMETRIC DETERMINATION OF THE AVERAGE TOTAL KINETIC ENERGY OF FRAGMENTS FROM FISSION OF $U^{235}$ AND $U^{238}$ BY 14-MEV NEUTRONS. P. C. Stevenson, H. G. Hicks, J. C. Armstrong, Jr., and S. R. Gunn (Univ. of California, Livermore). Phys. Rev. 117, 186-91(1960) Jan. 1.

The fission yields of $Mo^{99}$ from 14-Mev neutron bombardments of $U^{235}$ and $U^{238}$ were found to be (5.01 ± 0.15)% and (5.86 ± 0.16)%, respectively. The average total fragment kinetic energies released in fission of $U^{235}$ and $U^{238}$ were found to be 174 ± 4 and 175 ± 2 Mev, respectively. (auth)

**11101**

NEW NEUTRON-DEFICIENT ISOTOPE OF CERIUM. William R. Ware and Edwin O. Wiig (Univ. of Rochester, N. Y.). Phys. Rev. 117, 191-3(1960) Jan. 1.

Cerium-132, a positron emitter with a half-life of 4.2 ± 0.2 hours, was identified through its generic relationship to the known daughter nuclide, $La^{132}$. An activity of 30-minutes half-life and 4.2-Mev maximum positron energy, which may be due to $Ce^{131}$, was also observed. (auth)

**11102**

CROSS SECTIONS AND ANGULAR DISTRIBUTIONS FOR THE $B^{10}(\alpha,d)C^{12}$ REACTION FROM 3.2 MEV TO 3.8 MEV. Kazuo Ôno and Keiichi Kuroda (Univ. of Tokyo). Phys. Rev. 117, 214-15(1960) Jan. 1.

In order to investigate the possibility of direct interactions in ($\alpha$,d) reactions, the $B^{10}(\alpha,d)C^{12}$ reaction was studied for alpha-particle bombarding energies from 3.1 to 3.7 Mev. The yield curves are rather flat and show no typical resonance structures. The angular distributions show a peak at about $\theta_{c.m.} = 70°$ and an increase of intensity in the backward direction over the entire alpha-particle energy range. These results indicate that the $B^{10}(\alpha,d)C^{12}$ reaction proceeds mostly by direct processes, probably both stripping (or knock on) and heavy-particle stripping ones. (auth)

**11103**

DOUBLE BETA DECAY. Lothar Meichsner (Max-Planck-Institut für Chemie, Mainz). Phys. Rev. 117, 489-91(1960) Jan. 15.

Formulas for the probability of double $\beta$ decay including energy distributions and angular correlations of the emitted electrons according to the theory of Feynman and Gell-Mann are given. A strong dependence on the change of angular momentum exists. The formulas also exhibit interference between different intermediate states. The half-life of $Ca^{48}$ is calculated using matrix elements of j-j shell-model configurations. It is found to be $t \sim 10^{17}...10^{20}$ years. Actually, t will be much greater, since the matrix elements used are those of favored transitions. (auth)

**11104**

ANOMALOUS ELECTRIC DIPOLE CONVERSION COEFFICIENTS IN ODD-MASS ISOTOPES OF THE HEAVY ELEMENTS. F. Asaro, F. S. Stephens, J. M. Hollander, and I. Perlman (Univ. of California, Berkeley). Phys. Rev. 117, 492-505(1960) Jan. 15.

A detailed review is given of experimental data on the anomalous L- and M-shell conversion coefficients of low-energy electric dipole transitions observed in the decays of odd-A nuclei of high atomic number. The data are consistent in every case with the interpretation that the E1 conversion coefficients in the $L_{III}$ shell agree with the theoretical, model-independent coefficients calculated by Sliv and Band and by Rose. It is definitely established in several well-measured cases that the $L_I$ and $L_{II}$ coefficients are substantially larger than the theoretical values. The most striking anomaly occurs in the 84.2-kev transition in $Pa^{231}$, where the $L_I$ and $L_{II}$ coefficients are 21 and 15 times larger than the theoretical values, respectively. The experimental $L_I$ and $L_{II}$ coefficients are correlated with the lifetimes of the transitions, and it is shown that the magnitude of the anomaly ($L_I$ plus $L_{II}$) is proportional to the retardation in gamma-ray lifetime over that calculated from the single-proton formulas. No systematic trend was observed in the deviations of the $L_I$ and $L_{II}$ coefficients individually. (auth)

**11105**

NUCLEAR MAGNETIC MOMENTS FROM HYPERFINE STRUCTURE DATA. N. J. Ionesco-Pallas (Rumanian Inst. for Atomic Research, Bucharest). Phys. Rev. 117, 505-10 (1960) Jan. 15.

The nuclear magnetic moments determined from the hyperfine structure of the $^2S_{1/2}$ and $^2P_{1/2}$ states are systematically smaller than those determined by methods of magnetic resonance. The Breit-Crawford-Schawlow correction which takes into account the finite dimensions of the nucleus, together with the Bohr-Weisskopf correction which takes into account the spatial distribution of nuclear magnetism, succeed in explaining at least the order of magnitude in the preceding difference. In the two corrections, certain factors are determined graphically, while others are to a certain extent erroneous, owing to incomplete solving of the Darwin-Gordon differential system. All these difficulties are removed in the present paper and the final result is a completely analytical expression for the total correction. The numerical calculations made for $_{80}Hg^{199}$ starting from the ground state $^2S_{1/2}$ (Hg II) fall in good agreement with the value of the nuclear moment determined by magnetic resonance. (auth)

**11106**

EXCITED LEVELS IN $Mn^{56}$. N. D'Angelo (Argonne National Lab., Lemont, Ill.). Phys. Rev. 117, 510-13(1960) Jan. 15.

The half lives of the first three excited levels of $Mn^{56}$ were measured by looking at the cascade gamma rays from neutron capture in $Mn^{55}$. They are found to be $10.7^{+2}_{-3}$ m$\mu$sec, 4.9 ± 0.6 m$\mu$sec, and $\leq 0.5$ m$\mu$sec. A fairly plausible assignment of spins and parities to the first, second, and third excited levels of $Mn^{56}$ would seem to be $2^+$, $1^+$, and $2^+$, respectively. The technique described should be useful in those cases in which excited levels of unstable nuclei cannot be reached through beta decay. (auth)

11107

EXCITATION STUDY OF $F^{19}(n,\alpha)N^{16}$ WITH A $BaF_2$ CRYSTAL. Daniel M. Smith, Norman A. Bostrom, and Emmett L. Hudspeth (Univ. of Texas, Austin). Phys. Rev. 117, 514-16(1960) Jan. 15.

The scintillation properties of crystalline $BaF_2$ were investigated. It was found that this substance yields a reasonably well-defined photopeak when exposed to gamma rays from $Na^{22}$. With DuMont K1306 and 6292 photomultipliers, the signals from $BaF_2$ are about $1/5$ to $1/10$ as strong as those from NaI(Tl). With a $BaF_2$ crystal as a target, the excitation function for the $F^{19}(n,\alpha)N^{16}$ reaction was observed in the region from an apparent threshold near 3.2 Mev up to $E_n = 6$ Mev. Several new resonances were found in this region. The cross section generally increases with increasing neutron energy, rising from 85 mb at 4.48 Mev to 200 mb near 6 Mev. Absolute accuracy of cross-section measurements was ±15%. (auth)

11108

RADIOACTIVE DECAY OF LUTETIUM-174. R. G. Wilson and M. L. Pool (Ohio State Univ., Columbus). Phys. Rev. 117, 517-19(1960) Jan. 15.

Ytterbium oxide enriched to 98.4% in the 174 mass number was irradiated with 6-Mev protons. An activity of approximately 165-day half life was produced and assigned to $Lu^{174}$ by the identification of the ytterbium K x-ray and of the activities produced by similar proton irradiations of the other enriched isotopes of ytterbium. The observed activity of $Lu^{174}$ consists of the L and K x rays of ytterbium and 76.6- and 1228-kev gamma rays which are in coincidence. Because no beta radiation exists in the activity of $Lu^{174}$, the mode of decay is solely by electron capture to $Yb^{174}$. Approximately 31% of the disintegrations of $Lu^{174}$ are to the ground state of $Yb^{174}$. In addition to the 76.6-kev level of $Yb^{174}$, there is a 1305-kev level with a spin of 0+. The transitions of $Lu^{174}$ to the 1305-kev level of $Yb^{174}$ are by L capture only and the percentages of electron capture to the 76.6- and 1305-kev levels of $Yb^{174}$ are approximately 59 and 10, respectively. A spin of 1- is assigned to the ground state of $Lu^{174}$. (auth)

11109

NUCLEAR ORIENTATION OF $Mn^{56}$. Rudolf W. Bauer and Martin Deutsch (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. 117, 519-25(1960) Jan. 15.

The angular distribution and circular polarization of the gamma rays emitted from 2.6-hr $Mn^{56}$, polarized at low temperatures in cerium magnesium nitrate, were measured. Comparing the angular distribution results with angular correlation data it is possible to establish the spins of the 2.65- and 2.98-Mev excited states of $Fe^{56}$ as 2 uniquely. The amplitude mixing ratios $\delta(E2/M1)$ for the 1.81- and 2.13-Mev $\gamma$-rays are shown to be $+0.11 \pm 0.06$ and $-0.27 \pm 0.03$, respectively. Gamma anisotropies from aligned $Mn^{56}$ in the same cooling salt were studied; the results are compared with other Mn alignment experiments. From a simultaneous measurement of the angular distribution of the $\gamma$-rays from polarized $Mn^{52}$ and $Mn^{56}$, the ratio of the nuclear g-values $(g_{52}/g_{56}) = 0.47 \pm 0.05$ was determined, giving $\mu_{56} = 3.35 \pm 0.35$ nm. The results of the circular polarization experiment determine $\mu_{56}$ to be positive. (auth)

11110

ALPHA-ALPHA SCATTERING AT 7.56 MEV. N. Berk, F. E. Steigert, and G. L. Salinger (Yale Univ., New Haven) Phys. Rev. 117, 531(1960) Jan. 15.

Alpha particles scattered from a helium gas target at an incident energy of 7.56 Mev were observed in nuclear emulsions. The differential cross sections measured can be fitted with phase shifts of $\delta_0 = 70°$ and $\delta_2 = 100°$. (auth)

11111

DIFFERENTIAL AND TOTAL CROSS SECTIONS OF THE $B^{10}(d,p)B^{11}$ REACTION AT LOW-DEUTERON ENERGIES. Gordon R. Harrison, Gail D. Schmidt, and Cyril D. Curtis (Vanderbilt Univ., Nashville). Phys. Rev. 117, 532-5(1960) Jan. 15.

Differential cross sections were obtained for production of the four highest energy proton groups in the $B^{10}(d,p)B^{11}$ reaction at $E_d = 170$ to 250 kev and for the highest energy group at 140 kev. A laboratory angular range from 0 to 140° was covered by the scintillation spectrometer technique using a thin CsI(Tl) crystal. Gamow plots of the total cross sections yield slopes approximately equal to the value anticipated from the Coulomb barrier penetration factor. (auth)

11112

LOW-LYING LEVELS IN $P^{30}$. S. S. Yamamoto and F. E. Steigert (Yale Univ., New Haven). Phys. Rev. 117, 535-7 (1960) Jan. 15.

The reaction $Al^{27}(\alpha,n)P^{30}$ was studied at 8.15-Mev bombarding energy using nuclear emulsions as detectors. Neutron groups corresponding to Q values of $-2.70$, $-2.96$, $-3.59$, $-4.43$, and $-4.96$ Mev were observed. Comparison of the resulting energy level structure in $P^{30}$ with that obtained by other reactions suggests the possible inversion of the two isobaric spin ground states. (auth)

11113

ELECTRON SCATTERING BY THE QUADRUPOLE CHARGE DISTRIBUTION OF $N^{14}$. M. K. Pal (Univ. of Maryland, College Park). Phys. Rev. 117, 566-72(1960) Jan. 15.

The recent data of Meyer-Berkhout on the elastic scattering of 420-Mev electrons by $N^{14}$ were analyzed in the first Born approximation. A detailed treatment is given of the effect of the quadrupole charge distribution of the nucleus in causing a filling-up of the diffraction minimum. The intermediate coupling ground-state wave function of Visscher and Ferrell with an admixture of the spheroidal type of collective wave function, suggested by Fallieros and Ferrell, was used in calculating the quadrupole form factor. Instead of using the Born approximation monopole form factor, the exact monopole scattering curve computed by Ravenhall from phase-shift analysis was used. The spin-flip type magnetic scattering was calculated and found to be extremely small. The experimental data show the importance of the quadrupole charge scattering in the neighborhood of the diffraction minimum of the monopole scattering. The quadrupole scattering for the intermediate coupling is, however, completely inadequate to explain the observed data. This gives strong evidence for a collective enhancement of the $N^{14}$ quadrupole moment through core deformation. The model of Fallieros and Ferrell, which predicts a total quadrupole moment of $3.07 \times 10^{-26}$ cm$^2$ (collective enhancement = $2.01 \times 10^{-26}$ cm$^2$), is found to give a fairly good fit with the data. (auth)

11114

CROSS SECTIONS FOR THE PRODUCTION OF Cl, K, Ca, AND Sc ISOTOPES IN THE BOMBARDMENT OF Pb AND U WITH 3.0-Bev PROTONS. G. Friedlander and L. Yaffe (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 117, 578-81(1960) Jan. 15.

Cross sections for the formation of some nuclides in the mass number range 38 to 48 in the bombardment of Pb and

U with 3.0-Bev protons were measured. The maximum of the isobaric yield distributions for the nuclides from the Pb bombardment occurs at the stability line, while that from U is somewhat on the neutron-excess side. Total cross sections of 4 to 5 mb per mass number are deduced from the Pb data leading to a revision of the mass-yield curve in this region as proposed by Wolfgang et al. The cross sections from uranium are approximately twice as large as those from Pb. The data are shown to be consistent with a cascade-fission-evaporation mechanism. (auth)

**11115**

TWO-NUCLEON POTENTIAL FROM PION FIELD THEORY WITH PSEUDOSCALAR COUPLING. Masao Sugawara (Brookhaven National Lab., Upton, N. Y.) and Susumu Okubo (Univ. of Rochester, N. Y.). Phys. Rev. 117, 605-10(1960) Jan. 15.

The two-nucleon potential is derived from ps-ps pion field theory, using the Tamm-Dancoff method with the subsequent appropriate renormalization of the two-nucleon amplitude, up to orders $g^2(p/k)^2$ and $g^4(p/k)$, $g^2$ being the equivalent ps-pv coupling constant and p, k the nucleon (relative) momentum and rest mass, respectively. Neglected are the mass and charge renormalizations and the pion-pion scattering term. It is shown that the only quadratic term is $-V_2(r)(p^2/2k^2)$ + H.c., where $V_2(r)$ is the second order static potential. All remaining terms of order $g^2(p/k)^2$ are converted by a canonical transformation to terms of order $g^4(p/k)$ or a linear combination of a static and an L · S potential. In the case of ps-ps coupling, in particular, no velocity-dependent potential besides the quadratic one mentioned above follows from diagrams of one- and two-pion exchange without nucleon pairs; thus the nucleon-pair diagrams are the only source of an L · S potential, if there is any, up to the orders considered. The nucleon-pair diagrams are estimated assuming the effective pion-pair interaction Hamiltonian, the static limit of which agrees with the S-wave static model of Drell et al. The L · S potential thus obtained has the right sign in the odd state and changes its sign in the even state, while its magnitude seems in both states somewhat too small. As for the static part of our potential, the new correction $[g^4(\mu/k)]$ cancels out the conventional fourth-order term $[g^4]$ appreciably; the entire static potential becomes quite close to the second-order static potential down to distances of the order of the pion Compton wavelength, except for the central force in the triplet even state. The details are shown on graphs. The ps-pv coupling case is treated separately. (auth)

**11116**

TWO-NUCLEON POTENTIAL FROM PION FIELD THEORY WITH PSEUDOVECTOR COUPLING. Masao Sugawara (Brookhaven National Lab., Upton, N. Y.) and Susumu Okubo (Univ. of Rochester, N. Y.). Phys. Rev. 117, 611-13(1960) Jan. 15.

The two-nucleon potential is derived from ps-pv pion field theory up to orders $g^2(p/k)^2$ and $g^4(p/k)$, using the method outlined in the preceding paper, where it was applied to ps-ps theory. It is shown that the only quadratic term is $-V_2(r)(p^2/2k^2)$ + H.c. [$V_2(r)$ is the second-order static potential], just as in the ps-ps case. The static part is almost the same as the ps-ps potential. A big difference appears in the L · S potential; because of the difference in kinematical corrections from ps-ps and ps-pv vertices, large L · S potentials result from both one-pion and two-pion exchange diagrams (with no nucleon pairs), though no L · S potential follows from such diagrams in case of ps-ps theory. The entire L · S potential has the right sign in the odd state and is of the same sign and of larger magnitude [by a factor of two or three] in the even state. It is shown that this isospin dependence of the L · S potential is not appreciably modified even if, besides the ps-pv coupling term, two pion-pair terms are added which are fitted to low-energy S-wave pion-nucleon scattering. This big difference in the L · S potential could eventually be used to discriminate between ps-ps and ps-pv theories. Various L · S potentials, theoretical and phenomenological, are shown on graphs for comparison. (auth)

**11117**

DEUTERON MAGNETIC MOMENT AND MOMENTUM DEPENDENCE OF TWO-NUCLEON POTENTIAL. Masao Sugawara (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 117, 614-15(1960) Jan. 15.

The correction to the deuteron magnetic moment [$\mu_d$] is calculated, in the manner pointed out by Feshbach, for the potential derived recently by Sugawara and Okubo from pion field theory. This potential includes, besides an L · S potential, a quadratic term, $-V_2(r)(p^2/2k^2)$ + H.c. [$V_2(r)$ being the second-order static potential, p and k the nucleon (relative) momentum and rest mass, respectively]. It is shown in particular that this new term gives a positive correction to $\mu_d$. Numerical magnitudes are estimated using phenomenological deuteron wave functions fitted to all known deuteron data, the hard-core radius [$r_C$] and the D-state probability [$P_D$] being adjustable parameters. Results are shown graphically as functions of $P_D$ for two values of $r_C$. It is seen that the corrections depend sensitively on these two parameters. If there were no other appreciable corrections to $\mu_d$ than those discussed here, ps-ps theory would lead to 6% for $P_D$, while $\mu_d$ would not be fitted in the ps-pv case as well as for the Gammel-Thaler potential, since the correction due to the quadratic term is not large enough to cancel the correction due to the L · S potential. (auth)

**11118**

THE SCATTERING OF 38 Mev $\alpha$-PARTICLES BY C, N, O, F AND Kr NUCLEI. J. Aguilar and J. Catalá (Univ. of Valencia), W. E. Burcham and J. S. C. McKee (Univ. of Birmingham, Eng.), J. Rotblat (St. Bartholomew's Hospital, London), and J. B. A. England (Queen's Univ., Belfast). Proc. Roy. Soc. (London), A254, 395-407(1960) Feb. 23.

Observations by a photographic method are presented on the angular distributions of 38 Mev $\alpha$-particles scattered by light nuclei. Elastically and inelastically scattered particles were distinguished by their range in nuclear emulsion. The observed distributions are compared with the general predictions of the nuclear optical model, of direct interaction theories, and of the inelastic diffraction theory of Blair. Interaction radii are deduced from the angular distributions. (auth)

**11119**

INTERACTIONS OF ANTIPROTONS WITH NUCLEI. A. Engler, P. B. Jones, and J. H. Mulvey (Univ. of Oxford). Proc. Roy. Soc. (London), A254, 425-31(1960) Feb. 23.

The energy spectra of charged $\pi$-mesons emitted from 377 annihilations of antiprotons in emulsion nuclei were measured. Six charged K-mesons were observed; this figure corresponds to the production of charged K-mesons in (8 ± 3)% of annihilation events. Data on the mean free path of interaction of antiprotons with free protons and emulsion nuclei are presented and are in substantial agreement with results obtained previously. (auth)

**11120**

ON THE ANGULAR DISTRIBUTIONS IN (p,$\gamma$) AND (p,$\gamma$,$\gamma$)

REACTIONS. Lennart Simons (Univ. of Helsinki). Soc. Sci. Fennica, Commentationes Phy.-Math. 23, No. 2, 1-12(1959).

Triple angular correlation functions are calculated and compared with the results of the triple angular correlation measurements for the reactions $Na^{23}(p,\gamma)Mg^{24}$ and $Si^{30}(p,\gamma)P^{31}$. We obtain for the former reaction that the 515 keV level has $J = 2^-$ and the 679 keV level $J = 3^+$ and for the latter reaction again that the 760 keV resonance level has spin $^5/_2{}^+$, the 3.51 MeV level $^3/_2{}^+$ (possibly $^1/_2{}^+$) and the 2.23 MeV level $^5/_2{}^+$. (auth)

**11121**

FRAGMENTATION AND FISSION IN HIGH-ENERGY PARTICLE INTERACTIONS WITH NUCLEI. N. A. Perfilov, O. V. Lozhkin, and V. P. Shamov. Uspekhi Fiz. Nauk 70, 3-56(1960) Jan. (In Russian)

A review is presented of available data on the formation of multi-charged particles in nuclear fission and on the mechanism of nuclear fission at high excitation energies, a phenomena of special interest among the processes occurring during high-energy particle interactions with nuclei. (R.V.J.)

**11122**

MEASUREMENT OF THE v/c DEPENDENCE IN THE $\beta$-$\gamma$ CIRCULAR CORRELATION IN $Co^{60}$. Philipp Jäger (Universität, Erlangen, Ger.). Z. Physik 158, 214-25 (1960). (In German)

The circular polarization of the $\gamma$ radiation which results from the $\beta$ decay of $Co^{60}$ was measured in coincidence with $\beta$ particles in dependence on the energy of $\beta$ particles. The detection of the circular polarization of the $\gamma$ radiation is made by scattering in a magnetized iron hollow cylinder with alternating opposed magnetization direction. The $\beta$ energy was evaluated with a magnetic thin lens spectrometer which was surrounded by an iron mantle for shielding from external magnetic stray fields. The electronic recording is done with a fast-slow coincidence circuit with a resolution time of $2\tau = 1.1 \pm 10^{-8}$ sec. The results of $A = -0.361 \pm 0.082$ for $v/c = 0.69$ and $A = -0.203 \pm 0.138$ for $v/c = 0.51$ agree within statistical errors with the theoretically predicted v/c dependence of the polarization degree of the $\gamma$ radiation. (tr-auth)

**11123**

INTERNAL CONVERSION FACTORS IN $_{35}Br^{80m}$ (4.4 HR.). W.-D. Schmidt-Ott, K.-W. Hoffmann, I. Y. Krause, and A. Flammersfeld (Universität, Göttingen, Ger.). Z. Physik 158, 242-50(1960). (In German)

The intensities of the 37-kev and 49-kev $\gamma$ rays of $Br^{80m}$ were measured with the aid of NaI scintillation spectrometers and compared with the intensity of the conversion electrons registered by an anthracene split crystal spectrometer. It was possible to separate the 49-kev $\gamma$ radiation from the intense 37-kev line by selective absorption with balanced Sm and Gd filters. The internal conversion coefficients $\alpha$(49 kev) = 298 ± 30 and $\alpha$(37 kev) = 1.59 ± 0.10 are in good agreement with the calculated values for $M_3$ and $E_1$ transitions. The half life was measured yielding a value of $T_{1/2} = (4.40 \pm 0.05)$ hr. (tr-auth)

**11124**

RADIOCHEMICAL INVESTIGATION OF SPALLATION AND FISSION REACTION PRODUCTS RESULTING FROM THE BOMBARDMENT OF BISMUTH WITH 660-MEV PROTONS. A. N. Murin, B. K. Preobrazhenskii (Preobrazhensky) and N. E. Titov (Ehlopin Radium Inst. of the Academy of Sciences, USSR). p.329-36 of "Soviet Research on the Lanthanide and Actinide Elements, 1949–1957. PART III. Nuclear Chemistry and Nuclear Properties." (In English Translation). New York, Consultants Bureau, Inc., [1959]. $22.50.

The spallation and fission reaction products which result from the bombardment of bismuth with 660-Mev protons were investigated. The methods of isolating the reaction products, their measured formation cross section, and the yields of reaction products are given. The ratio of cross sections for fission and spallation reactions was found to be about 0.07. The fission reaction was preceded by 15 to 16 nucleons on the average. In the spallation reaction, 2 protons and 8 neutrons were ejected on the average. With increasing proton bombarding energy, a displacement of the yields into the stability region was noted. The mean excitation energy of the nuclei formed as a result of the nuclear cascade process was estimated at 90 Mev. (C.J.G.)

**11125**

ISOTOPE COMPOSITION OF THE RARE EARTH ELEMENTS FORMED IN THE FISSION OF URANIUM, THORIUM, AND BISMUTH NUCLEI BY PROTONS WITH ENERGY OF 680 MEV. F. I. Pavlotskaya and A. K. Lavrukhina. p.350-8 of "Soviet Research on the Lanthanide and Actinide Elements, 1949–1957. PART III. Nuclear Chemistry and Nuclear Properties." (In English Translation). New York, Consultants Bureau, Inc., [1959]. $22.50.

The isotopic composition of rare earths formed by the fission of U, Th, and Bi nuclei by 680-Mev protons was investigated. Separation by ion exchange chromatography was studied relative to the effect of the nature of the complex former (ammonium acetate, citrate, lactate, and oxalate), the pH of the eluant, and the concentration of the rare earths on the degree of separation. The most efficient separation was obtained by elution with 3.6% ammonium lactate solution at pH = 3.4. The isotopic composition and yields of $\beta$-active isotopes were determined. The yield of $\beta$-active isotopes of the rare earths formed in U fission was reported not to have changed when the proton energy increased from 340 to 680 Mev. (C.J.G.)

**11126**

DETERMINATION OF THE HALF-LIFE OF $Ac^{227}$ BY A CALORIMETRIC METHOD. N. S. Shimanskaya and E. A. Yashugina. p.359-60 of "Soviet Research on the Lanthanide and Actinide Elements, 1949–1957. PART III. Nuclear Chemistry and Nuclear Properties." (In English Translation). New York, Consultants Bureau, Inc., [1959]. $22.50.

Using a calorimetric method, the half life of $Ac^{227}$ was determined to be 21.2 ± 0.8 years. (C.J.G.)

**11127**

YIELDS OF CERTAIN HEAVY FRAGMENTS IN THE FISSION OF $U^{233}$. R. N. Ivanov, V. K. Gorshkov, M. P. Anikina, G. M. Kukavadze, and B. V. Ershler. p.390-2 of "Soviet Research on the Lanthanide and Actinide Elements, 1949–1957. PART III. Nuclear Chemistry and Nuclear Properties." (In English Translation). New York, Consultants Bureau, Inc., [1959]. $22.50.

The absolute yields of Cs, Ce, Nd, and Sm isotopes from the fission of $U^{233}$ were determined by the methods of isotope dilution and by integral mass spectrography. The results obtained by the two methods were in substantial agreement within the limits of experimental error. (C.J.G.)

**11128**
ENERGY LEVELS OF $Pu^{238}$ AND $Pu^{239}$ NUCLEI. S. A. Baranov and K. N. Shlyagin. p.393-407 of "Soviet Research on the Lanthanide and Actinide Elements, 1949–1957. PART III. Nuclear Chemistry and Nuclear Properties." (In English Translation). New York, Consultants Bureau, Inc., [1959]. $22.50.

The $\beta$ and $\gamma$ transitions in the decay of $Np^{238}$, $Np^{239}$, and $Cm^{242}$ were investigated using $\beta$ spectrometer, scintillation spectrometer, and proportional counter techniques. Possible spin values of the $Pu^{239}$ nuclear levels were determined and a hypothesis established as to the possibility of the existence of rotational levels for this even-odd nucleus. Possible energy level schemes for $Pu^{238}$ and $Pu^{239}$ are presented. (C.J.G.)

**11129**
MEASUREMENT OF THE EFFECTIVE NUMBER OF SECONDARY NEUTRONS FROM $Pu^{239}$ IN THE INCIDENT NEUTRON ENERGY REGION FROM 7 TO 30 EV. I. V. Kurpichnikov, V. V. Okorokov, and S. I. Sukhoruchkin. p.502-7 of "Soviet Research on the Lanthanide and Actinide Elements, 1949–1957. PART III. Nuclear Chemistry and Nuclear Properties." (In English Translation). New York, Consultants Bureau, Inc., [1959]. $22.50.

Measurements were made of the energy dependence of the quantity $\nu_{eff} = \nu(\sigma_f/\sigma_a)$ where $\nu$ is the average number of secondary neutrons emitted per fission event, and $\sigma_f$ and $\sigma_a$ are fission and absorption cross sections, respectively, in $Pu^{239}$ at 7 to 30 ev. From the data obtained, it was found that the fission widths of ten levels in $Pu^{239}$ vary strongly from one group to another and may be grouped about levels ~20 and ~60 to 80 mv. It was found that the radiative width was not strictly constant but changes from level to level. (C.J.G.)

**11130**
SPECTRA OF NEUTRONS INELASTICALLY SCATTERED ON $U^{238}$. N. I. Fetisov. p.519-22 of "Soviet Research on the Lanthanide and Actinide Elements, 1949–1957. PART III. Nuclear Chemistry and Nuclear Properties." (In English Translation). New York, Consultants Bureau, Inc., [1959]. $22.50.

The spectra of neutrons inelastically scattered by $U^{238}$ were measured with a Wilson cloud chamber. The scatterer was a spherical layer of impoverished U 18 mm thick. The energy distribution for the inelastically scattered neutrons was measured in the energy range from 100 to 1,300 kev and found to be in agreement with statistical theory. The most probable energy for the scattered neutrons was determined to be ~275 kev for neutrons with an initial energy of 2.5 Mev and ~375 kev for neutrons with an initial energy of 3.5 Mev. (auth)

**11131**
ENERGY LEVELS IN $Tm^{169}$. S. A. Baranov, R. M. Polevoi, Yu. (Iu.) F. Rodionov, and G. V. Shishkin. p.523-4 of "Soviet Research on the Lanthanide and Actinide Elements, 1949–1957. PART III. Nuclear Chemistry and Nuclear Properties." (In English Translation). New York, Consultants Bureau, Inc., [1959]. $22.50.

Energy levels and spins were determined for $Tm^{169}$, following an investigation of the decay of $Yb^{169}$. (C.J.G.)

**11132**
DETERMINATION OF THE ABSOLUTE INTENSITY OF THE 2.5 Mev LINE OF $\gamma$-EMISSION OF $La^{140}$. V. A. Arkhipov. p.525-6 of "Soviet Research on the Lanthanide and Actinide Elements, 1949–1957. PART III. Nuclear Chemistry and Nuclear Properties." (In English Translation). New York, Consultants Bureau, Inc., [1959]. $22.50.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 9374.

**11133**
THE INTERACTION OF SLOW NEUTRONS WITH NUCLEI. V. V. Vladimirskii, A. A. Panov, I. A. Radkevich, and V. V. Sokolovskii. p.527-47 of "Soviet Research on the Lanthanide and Actinide Elements, 1949–1957. PART III. Nuclear Chemistry and Nuclear Properties." (In English Translation). New York, Consultants Bureau, Inc., [1959]. $22.50

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 10899.

## Particle Accelerators

**11134** BNL-4632
Brookhaven National Lab., Upton, N. Y.
COSMOTRON MAGNET POWER SUPPLY. G. K. Green. July 21, 1954. 32p. (ADD-GKG-1). OTS.

The nominal rating of the Cosmotron power supply is 6000 v, open circuit, 7000 amp peak current, at regulation of approximately 25%. The power supply is 12 phase in order to minimize the ripple voltage appearing across the magnet, since no filter was designed into the system. Some of the devices, circuits, and circuit principles of the power supply are described. (W.D.M.)

**11135** BNL-4633
Brookhaven National Lab., Upton, N. Y.
TRANSIENT MAGNET RESPONSE IN THE OPERATION OF THE A.G.S. L. Jackson Laslett. Aug. 18, 1955. 26p. (ADD-LJL-10). OTS.

Following the application of a voltage pulse to the magnet of the AGS, it may be expected that the transient response will result in magnetic fields which vary with position around the ring structure. Such variations might give rise to undesirable disturbance of the equilibrium particle orbit. Numerical examples are provided, based on magnet parameters tentatively adopted. Explicit consideration is given to a circuit containing a series reactor, and special remedial measures are considered which are possible with the series reactor present in the magnet circuit. (W.D.M.)

**11136** BNL-4634
Brookhaven National Lab., Upton, N. Y.
LINEAR ACCELERATOR DRIFT TUBE SUPPORT. I. J. Polk. Feb. 28, 1956. 10p. (ADD-IJP-4). OTS.

The drift tubes for the linac are ellipsoidal in shape with a length varying from 2 to 15 inches and maximum diameter of about 9 inches. The system of support provides adjustments in orthogonal coördinates parallel to the directions in which aligning measurements are to be taken as well as providing for all adjustments necessary. (W.D.M.)

**11137** BNL-4635
Brookhaven National Lab., Upton, N. Y.
ORBIT CONSIDERATIONS IN THE LINEAR ACCELERATOR. Lloyd Smith. May 21, 1956. 31p. (ADD-LS-3). OTS.

The results of various calculations pertaining to the linear accelerator are summarized. Space charge effects are ignored. (W.D.M.)

**11138** BNL-4636
Brookhaven National Lab., Upton, N. Y.
LONG-TERM VERTICAL PILE LOAD TESTS. J. H. Lancaster. May 25, 1956. 5p. (ADD-JHL-2). OTS.

BNL-4639 supplements this report.

As a portion of the pile load tests required for the foundation design of the Brookhaven AGS, two long-term settlement tests were performed in order to obtain actual data on secondary settlement effects of piles driven in sandy soil. (W.D.M.)

**11139** BNL-4637
Brookhaven National Lab., Upton, N. Y.
CORRECTIONS TO BETATRON FREQUENCIES IN THE BROOKHAVEN ALTERNATING-GRADIENT SYNCHROTRON. Lloyd Smith. May 26, 1956. 16p. (ADD-LS-4). OTS.

The effect of small deviations from the idealized magnet configuration is discussed and the quantitative information available is presented. All pertinent computations carried out on Univac are included. Analytical estimates are given which agree well with Univac where the two methods overlap. (W.D.M.)

**11140** BNL-4638
Brookhaven National Lab., Upton, N. Y.
ALTERNATING GRADIENT SYNCHROTRON; SUMMARY FOUNDATION REPORT. John H. Lancaster. July 24, 1956. 16p. (ADD-JHL-3). OTS.

The procedure is summarized which was followed in the design of the foundation for the Brookhaven AGS, and the results of the various computations which lead to the decisions which were made are given in a generalized form. (W.D.M.)

**11141** BNL-4639
Brookhaven National Lab., Upton, N. Y.
LONG-TERM VERTICAL PILE-LOAD TESTS. J. H. Lancaster. July 30, 1956. 5p. (ADD-JHL-4). OTS.

This report supplements BNL-4636.

Supplementary data to BNL-4636 are presented. Piles 13 and 14 continued to settle at a uniform rate which amounted to 0.003 to 0.004 inch in the last 150 days. (W.D.M.)

**11142** BNL-4640
Brookhaven National Lab., Upton, N. Y.
SOME SATURATION CHARACTERISTICS OF ALTERNATING-GRADIENT MAGNET MODELS. M. H. Blewett. Oct. 2, 1956. 11p. (ADD-MHB-6). OTS.

Some of the data from the various magnet models were analyzed with respect to the saturation behavior; the contributions to this behavior of the various parameters such as profile shape, aperture size, packing factor, and permeability were sorted out. In particular, the data giving the decrease in the value of $n_0$ (or the more relevant quantity $dB/dx \div B_0$), at the center of the aperture, were related in a rather simple and self-consistent way with the values for an average maximum field in the pole tips. From the analysis, it is possible to predict, relatively speaking, the saturation behavior of other models with differing profiles or made of different steel. (auth)

**11143** BNL-4641
Brookhaven National Lab., Upton, N. Y.
BEAT FACTORS AND STOPBAND WIDTHS. E. D. Courant. Jan. 3, 1957. 13p. (ADD-EDC-24). OTS.

Errors in the field gradients have three effects on the motion of the particles in an AG field: (1) The oscillation frequencies are shifted. (2) Stopbands appear when the oscillation frequencies are integral or half-integral. (3) Outside the stopbands the amplitudes of the oscillations beat up and down so that the acceptance of a given aperture is reduced. Explicit expressions for the second and third effects are given. (W.D.M.)

**11144** BNL-4642
Brookhaven National Lab., Upton, N. Y.
TRANSIENT RESPONSE OF AGS MAGNET. H. S. Snyder. Jan. 24, 1957. 5p. (ADD-HSS-4). OTS.

For the purpose of estimating the transient response of the AGS magnet it is assumed that each of the 240 magnets is shunted with a resistance proportional to its inductance and that the capacity to ground of each magnet is proportional to its inductance. (W.D.M.)

**11145** BNL-4643
Brookhaven National Lab., Upton, N. Y.
BEAM OBSERVATION ELECTRODES FOR THE AGS. E. C. Raka. Mar. 26, 1957. 9p. (ADD-ECR-3). OTS.

Signals from induction electrodes will be used to determine the AGS beam position during the first few revolutions as well as to obtain an estimate of the harmonic content of the betatron oscillations in the circulating beam. Electrodes were designed that give essentially a linear variation of induced signal with displacements along a vertical or horizontal direction. (W.D.M.)

**11146** BNL-4644
Brookhaven National Lab., Upton, N. Y.
QUADRUPOLE AND SEXTUPOLE REQUIREMENTS. E. D. Courant. July 12, 1957. 4p. (ADD-EDC-26). OTS.

In the AGS quadrupoles are required to correct variations in $\underline{n}$ and sextupoles are required to correct nonlinearities in the field, both arising at injection and saturation. Twenty-four quadrupoles and thirty-six sextupoles both of length 22" and aperture 6" are required for adequate corrections. (W.D.M.)

**11147** BNL-4645
Brookhaven National Lab., Upton, N. Y.
LINAC TUNING SYSTEM. J. D. Kiesling. July 23, 1957. 17p. (ADD-JDK-2). OTS.

The AGS linac injector is designed to accelerate protons with a constant average accelerating gradient of 1.89 megavolts per meter. It is necessary to distribute a tuning mechanism along the length of the linac to tune the various portions of the tank to a common resonant frequency. It has been suggested that the tuning mechanism consist of a distributed number of metallic spheres. (W.D.M.)

**11148** BNL-4646
Brookhaven National Lab., Upton, N. Y.
INJECTION OPTICAL SYSTEM. Hugh N. Brown. Aug. 21, 1957. 18p. (ADD-HNB-1). OTS.

The general requirements of the injection system between the linear accelerator and the synchrotron are discussed. The specific equipment necessary to meet these requirements is described. It is felt that the system as described is close to its final form although the detailed design and drawings have not been done. (W.D.M.)

**11149** BNL-4647
Brookhaven National Lab., Upton, N. Y.
MAGNET SUPPORT SYSTEM. V. J. Buchanan. Jan. 2, 1958. 4p. (ADD-VJB-1). OTS.

The proposed method of supporting the AGS magnets consists of three elements which provide for the block to be located azimuthally, leveled, and moved radially. The elements are cross slides, leveling jacks, and the ball hydraulic pad. (W.D.M.)

**11150** BNL-4649
Brookhaven National Lab., Upton, N. Y.
LONG-TERM VERTICAL PILE LOAD TESTS. John H. Lancaster. Jan. 22, 1958. 3p. (ADD-JHL-6). OTS.

The results of the long-term vertical pile load tests are summarized for a period of 600 days. (W.D.M.)

**11151** BNL-4650
Brookhaven National Lab., Upton, N. Y.
RIPPLE FILTERING FOR MAIN AGS MAGNET GENERATOR. J. G. Cottingham. June 4, 1958. 4p. (ADD-JGC-14). OTS.

An electronic generator to oppose and cancel the ripple in the main AGS magnet generator is considered. The system cancels the ripple by developing across the saturable inductor a voltage equal and opposite to the ripple voltage. (W.D.M.)

**11152** BNL-4651
Brookhaven National Lab., Upton, N. Y.
A PARALLEL-TRANSISTOR CASCADED AMPLIFIER FOR CONTROLLING VERY LARGE CURRENTS. R. H. Rhéaume. Mar. 6, 1959. 7p. (ADD-RHR-5). OTS.

A method for controlling large currents at low voltages by means of paralleled high-power switching transistors was developed. The output current from a 3.5-volt 1000-ampere filtered Ge rectifier is made to flow through a low-impedance load at any desired rate by means of a series-regulator amplifier circuit consisting of three cascaded parallel-transistor amplifier stages. A relatively small control signal range is sufficient to sweep the output current from 0 to 1000 amperes. (W.D.M.)

**11153** BNL-4652
Brookhaven National Lab., Upton, N. Y.
MODES IN LONG CAVITIES. J. D. Kiesling. Apr. 2, 1959. 6p. (ADD-JDK-6). OTS.

The eleven tanks that comprise the accelerating structure will be resonated individually to within 20 kc of a common frequency before final assembly. It is expected that only a small amount of trimming will be required, either with the ball tuners or the end gaps. In flattening the AGC injector, it is possible to make a direct analogy between the accelerating cavity and the $E_{010}$ mode. (W.D.M.)

**11154** BNL-4653
Brookhaven National Lab., Upton, N. Y.
TENTATIVE PLANS FOR EXPERIMENTAL EQUIPMENT AT THE AGS. R. L. Cool and E. D. Courant. Apr. 9, 1959. 11p. (ADD-RLC/EDC-1). OTS.

A brief resumé is presented of the present tentative plans for general experimental equipment to be used during the first year of AGS operation. Time limitations on design, purchase, and fabrication are discussed. Magnets and beam separators, beams, and power supply are covered. (W.D.M.)

**11155** BNL-4654
Brookhaven National Lab., Upton, N. Y.
THE FOCAL PROPERTIES OF CERTAIN QUADRUPOLE LENSES. J. P. Blewett. May 11, 1959. 32p. (ADD-JPB-13). OTS.

The focal properties of a quadrupole lens system can be described by a tabulation of the locations of principal planes and of the focal lengths for various gradient strength in the lens elements. A derivation and tabulation of these parameters are presented for one, two, and three quadrupole systems. (W.D.M.)

**11156** BNL-4655
Brookhaven National Lab., Upton, N. Y.
ALIGNMENT OF AGS LINEAR ACCELERATOR TANK. J. W. Hart. May 12, 1959. 6p. (ADD-JWH-1). OTS.

The eleven tank sections of the linac are about 37 inches inside diameter and nearly 10 feet long. They are bolted together to make a single tube 110 feet long. The tanks are aligned to within plus or minus 0.005 inches of the reference beam line. Another requirement is the removal and replacement of a single tank to within ±0.003 inches of its original position. The scheme for meeting these requirements is discussed. (W.D.M.)

**11157** BNL-4656
Brookhaven National Lab., Upton, N. Y.
RELATIVISTIC CHARGED PARTICLE TRAJECTORIES IN CROSSED ELECTRIC AND MAGNETIC FIELDS. R. A. Beth. May 22, 1959. 6p. (ADD-RAB-7). OTS.

The attainable electric field strength in beam separators is limited by vacuum breakdown between the electrodes. In connection with various ideas for inhibiting breakdown, the trajectories of electrons starting from the cathode at zero velocity when a magnetic field is applied perpendicular to the electric field are calculated. (W.D.M.)

**11158** BNL-4657
Brookhaven National Lab., Upton, N. Y.
THE DYNAMIC K-METER. J. P. Palmer. June 10, 1959. 23p. (ADD-JPP-9). OTS.

The dynamic K-meter was designed primarily to record accurately the ratio of dynamic gradient to dynamic field, although it can be used to detect the difference between any two time-varying fluxes. Decade amplification, system operation, and use and reliability of the instrument are discussed. (W.D.M.)

**11159** BNL-4658
Brookhaven National Lab., Upton, N. Y.
A RADIOFREQUENCY BEAM SEPARATOR FOR COMPLETE SEPARATION OF HIGH ENERGY PARTICLE BEAMS. J. P. Blewett and J. D. Kiesling. Aug. 18, 1959. 17p. (ADD-JPB/JDK-1). OTS.

A combination of traveling-wave deflectors which can give separation between the desired and the undesired particles in a beam is considered. A possible deflector configuration is described and the necessary dimensions and power requirements are estimated. For purposes of illustration, the problem of removing the $\pi$-meson component from an antiproton beam is discussed. (W.D.M.)

**11160** BNL-4659
Brookhaven National Lab., Upton, N. Y.
SATURATING INDUCTOR FOR CONTROLLING THE MAGNETIC FIELD OF THE ALTERNATING GRADIENT SYNCHROTRON. E. J. Rutan. Oct. 23, 1959. 35p. (ADD-EJR-8). OTS.

The Brookhaven AGS was designed so that the field in the magnet rises to about 13,000 gauss in about one second. An investigation was made of the feasibility of a saturating inductor to control the main magnet field to the desired limits. The characteristics and design of the inductor are described. The specified performance and tests of the completed unit are included. (W.D.M.)

**11161** BNL-4660
Brookhaven National Lab., Upton, N. Y.
APPLICATION OF THE LINEAR ACCELERATOR FOR PRODUCTION OF INTENSE PROTON BEAMS AT 10 BEV. II. NEUTRINO BEAMS. J. P. Blewett. Nov. 25, 1959. 5p. (ADD-JPB-14). OTS.

A proposal to construct a 10-Bev proton linear accelerator is discussed in some detail. Leading parameters are tentatively given for the proposed machine. One advantage of the machine would be a relatively intense neutrino beam. (W.D.M.)

**11162** BNL-4661
Brookhaven National Lab., Upton, N. Y.
INTERIM DATA ON THE STABILITY OF AGS FOUNDATIONS. O. S. Reading. Jan. 26, 1960. 9p. (ADD-OSR-4). OTS.

Repeated precise surveys of the AGS since the first check location survey in June 1958 afford some indication of the future stability of the AGS foundations under load. Some brief data are presented which were abstracted from rather voluminous survey notes. (W.D.M.)

**11163** BNL-4689
Brookhaven National Lab., Upton, N. Y. DRIFT TUBE ALIGNMENT FOR THE AGS LINAC. A. Kevey. Mar. 17, 1960. 9p. (ADD-AK-1). OTS.

All drift tubes were positioned horizontally and vertically within ±0.015 inch prior to the axial alignment. The techniques for horizontal and vertical positioning are summarized. In the final method for locating drift tubes axially, the low energy end of each tank was selected as a reference point and dimensions were established to the high energy end of each drift tube in the tank. (W.D.M.)

**11164** MURA-491
Midwestern Universities Research Assn., Madison, Wis. DEVIATIONS FROM ADIABATIC BEHAVIOR DURING CAPTURE OF PARTICLES INTO AN R. F. BUCKET. C. G. Lilliequist and K. R. Symon. July 20, 1959. 19p. Contract AT(11-1)-384. OTS.

Capture of particles into stable synchrotron oscillations for a constant frequency accelerating voltage is studied for various voltage turn-on programs. Results are given for various linear voltage turn-on rates, and for two rates of turn-on with a non-linear voltage function V(t) designed to insure a constant degree of adiabaticity for all particles captured. A satisfactory form of the voltage turn-on function V(t) is found for which particles are captured into stable sychrotron oscillations along curves in the phase space whose areas differ from the adiabatic value by an rms deviation of about 12%. (auth)

**11165** MURA-507
Midwestern Universities Research Assn., Madison, Wis. ESTIMATE OF RADIATION LEVELS FOR THE MURA 50 MEV ELECTRON ACCELERATOR. Willy Smith. Sept. 8, 1959. 8p. Contract AT(11-1)-384. OTS.

A rough calculation of the expected levels of radiation for the present shielding is made. (auth)

**11166** MURA-537
Midwestern Universities Research Assn., Madison, Wis. MAGNETO-GRAVITATIONAL EFFECTS IN PARTICLE ACCELERATORS. L. W. Jones and A. M. Sessler. Apr. 1, 1960. 8p. Contract AT(11-1)-384. OTS.

That gravitational effects can be important in the design and operation of particle accelerators is generally believed not to be true. It has been pointed out that the effect of gravitation on the trajectories of particles can, in certain cases, be compensated by suitably designed magnetic guide fields. Attention is directed to a first order effect in the theory of general relativity, whose consequences for some accelerators can be pronounced—leading, in fact, if no corrections are made to the present designs, to breakdown of predicted behavior. (auth)

**11167** MURA-553
Midwestern Universities Research Assn., Madison, Wis. MAGNETIC FIELD CALCULATIONS USING DISTRIBUTED CURRENTS. S. C. Snowdon. Jan. 8, 1960. 11p. Contract AT(11-1)-384. OTS.

A modification of the standard algorism for obtaining solutions of the scaled Laplace equation is introduced in order to permit the use of this equation in the solution of certain magnetostatic problems involving distributed currents. Application is made to the case of an FFAG spiral sector magnet. (auth)

**11168** UCRL-9006
California. Univ., Berkeley. Lawrence Radiation Lab. ARBITRARY CONTROL OF THE RADIAL POSITION OF THE INTERNAL BEAM OF THE BEVATRON. Harry G. Heard. Jan. 1960. 13p. Contract W-7405-eng-48. OTS.

A relay-operated function generator is described that develops time-dependent program signals to establish discrete control of the radial position of the Bevatron beam. This computer has three independent channels. It may be used at any instant during the acceleration or deceleration cycle of the synchrotron. The unit is transistorized and designed for high reliability. (auth)

**11169** UCRL-9011
California. Univ., Berkeley. Lawrence Radiation Lab. BEVATRON OPERATION AND DEVELOPMENT. XXII. [Period covered] May, June, July 1959. Walter D. Hartsough. Dec. 1959. 13p. Contract W-7405-eng-48. OTS.

A beam aperture for an external proton beam was made at the west straight section. This facility will allow further study of internal-beam deflection systems. The research effort was directed toward the investigation of p-$\bar{p}$ cross sections and antihyperon production, $\pi^{\pm}$-nucleon cross sections, $\theta_2^0$ decay and interactions, and $\theta_1$-$\theta_2$ mass difference. (For preceding period see UCRL-8927.) (auth)

**11170**
THE OAK RIDGE RELATIVISTIC ISOCHRONOUS CYCLOTRON. PART II. MAGNETIC FIELD DESIGN FOR THE ISOCHRONOUS CYCLOTRON. B. L. Cohen, H. G. Blosser, E. D. Hudson, R. S. Lord, and R. S. Bender (Oak Ridge National Lab., Tenn.). Nuclear Instr. and Methods 6, 105-25 (1960) Jan. (In English)

The model magnet work and design studies which resulted in the selection of a three-sector azimuthally varying magnetic field with weak spiral are described. A four-sector, tight-spiral field was also considered. (auth)

**11171**
A MODULATOR FOR THE BONN SYNCHROCYCLOTRON WITH A FERROELECTRIC CERAMIC. Hanno Brückmann (Universität, Bonn). Nuclear Instr. and Methods 6, 169-75 (1960) Jan. (In German)

The frequency modulation system for the University of Bonn 190 cm synchrocyclotron is described. The unusual feature of this system is the use of Ba–Sr–$TiO_3$ sinter ceramic capacitors for the variable capacity. A 4.3% frequency modulation is obtained at 11 Mc/s with 24 capacitors (0.6 mm thick and 11 mm dia, mounted in xylene) each controlled by a low frequency modulating voltage up to 1400 volts. Design problems, concerning heat transfer and breakdown are discussed. The main advantage of this system is that many modulating wave-shapes and repetition rates are possible. (auth)

**11172**
ON A DESIGN OF WIDE RANGE MAGNET FOR CYCLOTRON. Hiroo Kumagai (Univ. of Tokyo). Nuclear Instr. and Methods 6, 213-16(1960) Jan. (In English)

A design principle of electromagnets is described in which the magnetic induction B in the pole iron is constant. By this design, we can have a constant relative distribution of magnetic field in the gap for a wide range of field. Results of applications in two cases are described. (auth)

**11173**
A PLASMA BETATRON. P. Reynolds and H. M. Skarsgard (European Organization for Nuclear Research, Geneva). J. Nuclear Energy, Pt. C, Plasma Phys.—Accelerators—Thermonuclear Research 1, 36-9(1960) Oct.

An apparatus is described in which betatron acceleration is applied to electrons in a plasma. A runaway electron current of 1 amp at an energy of 2 Mev was obtained. (auth)

**11174**

ON THE STUDY AND DESIGN OF CYCLIC ELECTRONIC ACCELERATORS AT THE TOMSK POLYTECHNIC INSTITUTE. A. A. Vorob'ev (Vorobiev) and V. A. Moskalev. J. Nuclear Energy, Pt. C, Plasma Phys.—Accelerators—Thermonuclear Research 1, 89-95(1959) Oct.

A short account is given of the results from studies on cyclic electron accelerators performed since 1946 at the Tomsk Polytechnic Institute. The basic design data and special constructional features of several betatrons are described. Various methods are discussed for extracting the electrons from the betatron accelerating chamber. A betatron producing 25 Mev electrons is described. The use of annular accelerating electrodes connected to an external two wire resonant transmission line in a 30 Mev synchrotron is reported. (auth)

**11175**

A NEGATIVE-ION INJECTOR FOR A CHARGE-EXCHANGE ELECTROSTATIC GENERATOR. J. Nuclear Energy, Pt. C, Plasma Phys., Accelerators, Thermonuclear Research 1, 96(1959) Oct.

A negative ion injector for a charge-exchange electrostatic generator is described, for which ion intensities of 70 μamp, 0.17 μamp, and 40 μamp were obtained for hydrogen, helium, and oxygen, respectively. (B.O.G.)

**11176**

BETATRON ENERGY CALIBRATION BY MAGNETIC FIELD MEASUREMENT. A. S. Penfold and E. L. Garwin (Univ. of Chicago). Rev. Sci. Instr. 31, 155-63(1960) Feb.

The technical features of a system for the determination and control of the operating energy of a 100-Mev betatron are described. The system is based on a determination of the magnetic field at the tip of the x-ray target at the instant of x-ray production. It is believed that an accuracy of 0.25% was obtained. (auth)

**11177**

MASS SEPARATION OF HIGH ENERGY PARTICLES IN QUADRUPOLE LENS FOCUSING SYSTEMS. E. D. Courant and L. Marshall (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr. 31, 193-6(1960) Feb.

In systems for mass separations of high-energy particles, the separation achieved depends not only on the applied electric field but also on the characteristics of the systems of magnetic lenses which may be used to contain and focus the beam of particles. Quantitative relations for the mass separation and momentum dispersion are derived. It is shown that systems can be designed involving a module of magnetic lenses and electric field such that, when the module is repeated indefinitely, the mass separations at successive foci increase linearly with the number of modules. (auth)

**11178**

AN APPROXIMATE LENS FOR HIGH ENERGY PARTICLES. David Luckey (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr. 31, 202-3(1960) Feb.

A description is given of a wire lens, composed of nineteen conductors, for approximating the required uniform field density of a restoring force on a charged particle. The lens has operated at currents up to 1000 amp (at a power of 38 kw). At 1000 amp per conductor the average gradient is about 46 gauss per cm. A comparison to the standard quadrupole lens is made. (C.J.G.)

**11179**

REDUCTION OF SURFACE CHARGES IN ION BEAM APPARATUS. Einar Lindholm (Royal Inst. of Tech., Stockholm). Rev. Sci. Instr. 31, 210(1960) Feb.

Painting the repeller plate surface in an ion beam apparatus with a dispersion of colloidal graphite in alcohol reduced the potential of the plate to less than 0.5v. No surface charges were formed on the plate. (C.J.G.)

**11180**

ON THE INJECTION THEORY IN CYCLIC ACCELERATORS WITH LARGE CURRENT. A. N. Lebedev (Lebedev Inst. of Physics, Moscow). Zhur. Tekh. Fiz. 29, 1339-45 (1959) Nov. (In Russian)

The mechanism of continuous injection into an annular phasotron at strong current with considerable collective particle interaction was studied. The collective capture factor was derived as a function of injection current. (tr-auth)

**11181**

SOURCE OF NEGATIVE IONS. Ya. M. Fogel, A. G. Koval, and A. D. Timofeev (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zhur. Tekh. Fiz. 29, 1381-7 (1959) Nov. (In Russian)

Descriptions are presented of the construction and characteristics of a negative ion source designed as an injector for a horizontal recharge electrostatic accelerator. The ion gun and focusing lens are identical to those designed by J. A. Weinman et al. (Rev. Sci. Instr. 27, 288(1956)). However, in the source described the transformation from positive to negative takes place in a mercury vapor target, demanding a lower capacity pump (1000 l/sec instead of 7000 l/sec) and resulting in a lower pressure in the source chamber ($8 \times 10^{-6}$ mm mercury). Currents of higher magnitudes than any previously mentioned in publication were obtained for negative ions $H^-$, $He^-$, and $O^-$. The source performs also with other negative ions. The source shows good ion beam stability with fluctuations not exceeding ±3% of the magnitude of the current. (R.V.J.)

**11182**

ON THE EFFICIENCY OF DIFFERENT PARTS OF INJECTION PULSE WITH CAPTURE OF ELECTRONS IN BETATRON. D. P. Ivanov and Yu. S. Korobockho (Inst. of Physics and Tech., Academy of Sciences, USSR). Zhur. Tekh. Fiz. 29, 1414-15(1959) Nov. (In Russian)

It is suggested that the relative yields of $\gamma$ rays from electron capture in the front or back section of the injection pulse are determined by the injector cathode emission properties rather than by details of the capture process. (R.V.J.)

## Plasma Physics and Thermonuclear Processes

**11183** AD-32860

Michigan. Univ., Ann Arbor. Engineering Research Inst.

PLASMA FLUCTUATIONS IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Technical Report No. 2 [on] ELECTRICAL MEANS OF PRODUCING HIGH VELOCITY WIND. Hugh W. Batten and Harold C. Early. May 1954. 155p. ERI Project 1989-1-T. DA Project No. 599-16-005. Contract DA-20-018 ORD-11913.

Theoretical and experimental study of electrical fluctuations of gas discharges in magnetic fields is reported. The theory includes both ionic and electron fluctuations.

The experimental studies were conducted in a specially constructed diode. The gas, pressure, magnetic field, power, type of probe, and probe location were varied, and the power spectrum was studied over a broad frequency range. (T.R.H.)

**11184** NYO-8061
Princeton Univ., N. J. Project Matterhorn.
PROPOSAL FOR A SMALL PLASMA SOURCE. Technical Memo No. 59. Francis F. Chen. Mar. 14, 1958. Changed from OFFICIAL USE ONLY Feb. 15, 1960. 32p. Contract AT(30-1)-1238. OTS.

The construction of a small plasma source is proposed which could be used to develop, test, and calibrate instruments. Design parameters of the machine are given. Possible experiments on probe theory, magnetohydrodynamic waves, plasma oscillations, and instabilities are discussed. (W.D.M.)

**11185** NYO-8071
Princeton Univ., N. J. Project Matterhorn.
A PROPOSAL FOR A LINEAR PLASMA SOURCE L-2. Technical Memo No. 68. Francis Chen, Joseph File, and E. W. Lehmann. Feb. 23, 1959. Changed from OFFICIAL USE ONLY Feb. 15, 1960. 52p. Contract AT(30-1)-1238. OTS.

A summary of the ideas on the purpose and design of the L-2 electric discharge plasma source is presented. Estimates of cost and delivery at a stage following the preliminary design but preceding the detailed design of the machine are included. (J.R.D.)

**11186** ORNL-2914
Oak Ridge National Lab., Tenn.
EFFECT OF PLASMA POTENTIAL ON DCX STEADY STATE. T. K. Fowler. Mar. 24, 1960. 26p. Contract W-7405-eng-26. OTS.

The mean energies $E_+$ and $E_-$ of ions and electrons in DCX at steady state after "burnout" were calculated taking into account the plasma potential. It was found that, because electrons are scattered more readily than ions, the plasma charges positively to a potential $\sim E_-/e$ in order to restrict electron escape. This has the consequence that a cold electron entering the plasma obtains approximately its full energy, $E_-$, through the reversible process of falling through the potential, and it gives back approximately all this energy on escape. Thus, for not too great a rate of streaming of electrons through the plasma, and neglecting radiation, the mean energy of ions inside the plasma, $E_+$, is less than their energy at injection only because the positive ions lose energy entering against the plasma potential. It is shown that $E_-$ decreases with increasing electron streaming, hence the potential decreases, and, for moderate streaming, $E_+$ increases. This trend in $E_+$ reverses when the net energy loss to electrons becomes appreciable, and therefore there is an optimum electron streaming rate for which $E_+$ is maximum. (auth)

**11187** UCRL-5424-T
California. Univ., Livermore. Lawrence Radiation Lab.
CIRCUIT DYNAMICS OF THE PINCH. J. Killeen and B. A. Lippmann. Feb. 1960. 26p. Contract W-7405-eng-48. OTS.

Instead of analyzing a portion of a hydromagnetic pinch apparatus in detail, and replacing the remainder by a boundary condition, the entire pinch apparatus is treated as a single dynamical system. A circuit equation and a mechanical equation, coupled together, result. These equations describe the dynamical development of the pinch and exhibit explicitly its dependence on the physical parameters (electrical and mechanical) of the system. As examples, the equations were used to analyze the snow-plow model and the adiabatic pinch, yielding curves that show the geometrical development of the pinch in time, as well as the distribution of mechanical and magnetic energies at any stage. Analogous analyses may be made for other physical quantities of interest, and can be used to adjust the parameters of the system so as to optimize specific pinch characteristics. (auth)

**11188** UCRL-5697
California. Univ., Livermore. Lawrence Radiation Lab.
ENERGY LOSS OF FAST IONS TO A SEA OF CONSTANT TEMPERATURE ELECTRONS. Francis C. Gilbert. Nov. 1959. 7p. Contract W-7405-eng-48. OTS.

In some proposed thermonuclear machines it is of interest to know the energy of an injected ion as a function of the time after injection. In particular, devices which make use of high-energy ions produced by charge exchange in an arc are susceptible to large energy losses via the cold electrons in the arc. The energy of an energetic ion in a Maxwellian distribution of cold electrons is calculated as a function of time. (W.D.M.)

**11189** UCRL-5722
California. Univ., Livermore. Lawrence Radiation Lab.
MAGNETOHYDRODYNAMIC FLOW. Edward A. Soltysik. Nov. 1959. 33p. Contract W-7405-eng-48. OTS.

A discussion is presented of both the continuous and discontinuous flow of an ionized gas in a magnetic field. The behavior of the ionized gas is discussed from the point of view of magnetohydrodynamic theory, in which all physical quantities are described in terms of analytic functions of space and time. The initial sections of this paper discuss the flow when all physical quantities vary continuously, while the final sections deal with the flow under shock conditions. It is shown that the magnetic field in the ionized gas causes an increase in the "sound" velocity, the shock velocity, and the fluid velocity. A number of simple examples of continuous and shock flow are given. (auth)

**11190** UCRL-9002
California. Univ., Berkeley. Lawrence Radiation Lab.
and California. Univ., Livermore. Lawrence Radiation Lab.
CONTROLLED THERMONUCLEAR RESEARCH QUARTERLY REPORT [FOR] SEPTEMBER, OCTOBER, NOVEMBER 1959. Dec. 10, 1959. 148p. Contract W-7405-eng-48. OTS.

Pyrotron Program: Efforts of the Pyrotron group were concerned primarily in four areas: (a) intensive study of plasma injection and trapping into static magnetic fields of various configurations, (b) detailed analysis of the data obtained in Table Top experiments, in order to document the existence of a stably confined plasma, (c) additional analysis of the plasma in the $P^4$ plasma generator, and (d) ion source, vacuum pumping, and theoretical build-up studies of the ALICE fast neutral atom injection studies. High-energy Injection: A parameter study of the high-energy molecular-ion injection system was made. The status of the experiment on $D_2^+$ dissociation at the time it was discontinued is summarized. Astron Program: An initial formulation of the problem of interaction of electron beams of finite size with an infinite plasma was attempted. The results are described briefly, as well as the contemplated steps for the solution of this problem under the parameters and geometry of the E layer. Calculations were extended on the self-consistent field of the E layer, including the slow-down process. For the parameters of interest it appears that a smooth transition from unreversed to reversed field is possible. The design of the 2-Mev accelerator is discussed. The general design was completed for the modified gun, which will provide a 200-amp electron beam. Pinch Program: Work at Livermore is reported on the linear hard-core pinch, small levitron experiment, electron-beam pinch, plasma acceleration, liquid sodium experiment, the 12-inch levitron, high magnetic field research, and theory. The Berkeley work on sheet pinch studies and the homopolar program is summarized. General Studies: Liner power dissipation and liner current as a function of axial position at various magnetic field configurations were measured in the ion magnetron to study the processes of ion loss. Under theoretical research the heating up of electrons in a plasma, scattering loss rate in mirror geometry, and hydromagnetic stability of a tubular pinch are discussed. Basic Experimental Research: Work is reported in the areas of plasma physics and microwave diagnostics, hydromagnetic wave propagation, axial transfer of r-f energy to the center of a magnetic mirror, beam research, and ion source development. Developments in ultra-high vacuum, cryogenic pumping, mechanical engineering, and electrical engineering are summarized. (For preceding period see UCRL-8887.) (W.D.M.)

**11191** WADD-TR-59-486(Pt.I)
Massachusetts Inst. of Tech., Cambridge. Naval Supersonic Lab.
A REVIEW OF THE LITERATURE OF PLASMA PHYSICS. PART I. Technical Report 373. Eugene E. Covert and Keith Kerney. July 1959. 184p. Project No. 7073. Contract AF33(616)-5693. OTS.

The level of development of plasma physics is discussed. It is found that the present theories account for the experimental effects if: (1) the plasma is sufficiently dense that the time between collisions is small compared to the time an atom stays in the excited state but is sufficiently rare that the volume of the particles making up the plasma is very much smaller than the volume of plasma, (2) the potential energy between particles is the sum of the particles potential energy, (3) the excitations are sufficiently weak, or the duration of the event is sufficiently short, that linearized theories are applicable. The complexity of the basic equations allows the inference to be drawn that it is possible for interesting phenomena to exist which are not yet discovered, and that the known but unexplained phenomena are contained within these equations. (auth)

**11192**
THE MOTION OF CHARGED PARTICLES IN A ROTATING PLASMA. B. Bonnevier and B. Lehnert. Arkiv Fysik 16, 231-42(1960). (In English)

The confinement of charged particles by magnetic mirrors in a rotating plasma is considered. The forbidden regions of a charged particle in crossed electric and magnetic fields are discussed with special attention to the centrifugal and Coriolis forces. It was found that, under certain conditions, particles will move almost along the magnetic field lines and will be completely reflected at the mirrors by means of the centrifugal force. A high reflection power is obtained by fields with large radial extensions such as that generated by a circular current loop. (auth)

**11193**
MASS SPECTROMETRIC AND SPECTROSCOPIC STUDY OF AN ION SOURCE HYDROGEN DISCHARGE. A. I. Nastyukha, A. R. Striganov, I. I. Afanas'ev, L. N. Mikhailov, and M. N. Oganov. Atomnaya Energ. 8, 44-6 (1960) Jan. (In Russian)

A triple prism spectrograph with a focusing distance of 840 mm and reverse linear disperson of 38 A/mm in the 6500 A region was used in studies of hydrogen discharge spectra. The data indicate that the degree of dissociation in the ion source and the proton yield depend on the location of the gas supply. The influx of gas and the discharge potential and current are also of great importance. The similarity of the dissociation and ionization curves for variable discharge parameters indicates a two-step process of proton production, $H_2$ dissociation first, followed by atomic ionization. A larger yield of protons during gas feeding into the discharge channel results from a larger number of molecules interacting with electrons than in the case of gas feeding into the cathode. It is also possible that in gas-discharge channel feeding, gas particles interact with slower electrons. (R.V.J.)

**11194**
MAGNETOHYDRODYNAMICS. Bernard Steginsky (Battelle Memorial Inst., Columbus, Ohio). Battelle Tech. Rev. 9, 1-8(1960) Feb.

The fundamental mechanisms of magnetohydrodynamics are discussed. Applications to the study of flow problems, heat transfer reduction and drag modification, and the acceleration of gases are considered. (C.J.G.)

**11195**
ELECTRIC AND MAGNETIC PROPERTIES OF PLASMA OF LOW POWER PULSE DISCHARGES. B. Piekara (Technical Univ., Danzig). Bull. acad. polon. sci., Sér. sci., math., astron. et phys. 7, 741-4(1959). (In English)

The electric and magnetic properties of a plasma with maximal power of $10^6$w were studied. The axial electrostatic potential distribution in plasma was determined. The influence of the longitudinal and transverse magnetic field on the intensity of the light emitted by a plasma was investigated. (C.J.G.)

**11196**
RADIATION LOSSES IN COMPLETELY IONIZED PLASMA. J. Kvasnica (Faculty of Technical and Nuclear Physics, Prague). Czechoslov. J. Phys. 10, 14-21(1960). (In English)

The losses caused by bremsstrahlung during electron-ion and electron-electron collisions in a completely ionized plasma (in Born's approximation) are calculated. The calculation is carried out analytically for a sufficiently dilute plasma (plasma with infinitely large Debay-Hückel radius). A dependence of the form $I = an^2 \sqrt{\tau}(1 + 3/\sqrt{2\tau})$, where $a = 0.73 \times 10^{-16}$ Mev cm$^3$ sec$^{-1}$, n is the number of ions per cm$^3$ and $\tau = kT/mc^2$, is determined for the amount of energy radiated from 1 cm$^3$ of plasma per sec. In the relativistic temperature region $kT \approx mc^2$ the influence of electron-electron collisions is shown to predominate. Electron-ion collisions were found to obey the expression $I^{(e,i)} = 0.52 \times 10^{-30} n^2 T^{1/2}$ w/cm$^3$. (auth)

**11197**
THE COLLISIONS OF TWO PLASMA STREAMS. A. Hruška (Astronomical Inst., Czechoslovak Academy of Sciences, Prague). Czechoslov. J. Phys. 10, 33-9 (1960). (In English)

The mutual interaction of two colliding plasma streams is investigated by means of the perturbation method. The disordered random motions of electrons are taken into account. It is shown that electron oscillations occur only when certain conditions as to the density and relative velocity of the colliding streams are fulfilled. The order of magnitude of the thickness of the shock generated by the initial relative motion is estimated on various assumptions. (auth)

**11198**
TRANSPOSITION OF EQUATIONS FOR PLASMA HYDRODYNAMIC APPROXIMATIONS. V. S. Tkalich. Izvest.

Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Mekh. i Mashinostr. No. 5, 122-3(1959) Sept.-Oct.

A transposition of a system of equations for plasma hydrodynamic approximation is made considering that the plasma is a uniformly charged incompressible ($n_k \doteq$ const.) ideal fluid. The analysis is carried out in an arbitrary orthogonal coordinate system. (R.V.J.)

**11199**

SOME DATA ON LOW-PRESSURE HIGH-FREQUENCY DISCHARGE. G. N. Zastenker and G. S. Solntsev (Lomonosov Moscow State Univ.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 934-40(1959) Aug. (In Russian)

The process of high-frequency discharge formation in argon with a field frequency of 3.3 MHz and at 0.4 to 15 mm mercury pressure is investigated. (R.V.J.)

**11200**

STUDIES OF SELF-CONTAINMENT SUPER-HIGH-FREQUENCY DISCHARGE IN THE AIR. P. S. Bulkin, G. S. Solntsev, and V. N. Ponomarev (Lomonosov Moscow State Univ.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 941-7(1959) Aug. (In Russian)

A method is developed for determining the processes of super high-frequency discharge formation in air at 9400 MHz frequency in the pressure range 0.1 to 40 mm mercury. (R.V.J.)

**11201**

SUPER-HIGH-FREQUENCY PROBE METHOD FOR MEASURING CHARGE CONCENTRATIONS IN PLASMA. S. M. Levitskiĭ and I. P. Shashurin (Kiev State Univ.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 948-51(1959) Aug. (In Russian)

The high-frequency oscillation system penetrating into the plasma but locally concentrated was used. The construction of the probe and the excitation system are described. Measurements of local electron concentrations by probing the plasma are shown to be feasible; however, the results of the measurements were distorted by ionic layers appearing at the probe surface. Further work was initiated with the purpose of eliminating these interfering perturbation effects. (R.V.J.)

**11202**

APPEARANCE OF SUPER-HIGH-FREQUENCY PULSE DISCHARGE IN INERT GASES. V. E. Golant (Kalinin Leningrad Polytechnic Inst.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 952-7(1959) Aug. (In Russian)

The results of calculations of $\nu$ for krypton and xenon are presented. The data are used for estimating the critical intensity for the appearance of high-frequency discharge in inert gases. (R.V.J.)

**11203**

THE RELATIONSHIP BETWEEN THE SUPER-HIGH-FREQUENCY AND DIRECT CURRENT CHARACTERISTICS. V. E. Golant (Kalinin Leningrad Polytechnical Inst.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 958-61(1959) Aug. (In Russian)

Conditions are formulated for describing the congruence of direct-current and high-frequency discharges in gases. Examples of "direct-current analogy" applications are given. (R.V.J.)

**11204**

DEVELOPMENT OF HIGH TEMPERATURE BY SPARK DISCHARGE. M. P. Vanyukov and A. A. Mak. Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 962-4(1959) Aug. (In Russian)

Data on spark discharge channel temperature were obtained by measuring the spectral lines in the gravity center preceding the moment of glow saturation. The linear emission was studied in argon at λ = 4806, 4348, and 3588A; in xenon at λ = 2900 and 2600; and in nitrogen at λ = 5045, 5011, and 4097. (R.V.J.)

**11205**

THE INFLUENCE OF NEGATIVE ION DISAPPEARANCE PROCESSES ON THEIR CONCENTRATION IN THE PLASMA COLUMN. M. V. Konyukov (Tula Pedagogical Inst., USSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 971-4(1959) Aug. (In Russian)

The influence of decay processes on negative ion concentrations was studied in the positive plasma column of electronegative gases in order to determine their effects on the abnormal behavior of the gradient, formation parameters, pinch, and other properties. (R.V.J.)

**11206**

NEW DATA ON LONG SPARKS. I. S. Stekol'nekov (Inst. of Power Engineering, Academy of Sciences, USSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 975-9(1959) Aug. (In Russian)

The development of sparks 1 to 5 m long was studied with specially constructed oscillographs, multicell shutters, electron-optic transformers, and a-c and d-c probes. (R.V.J.)

**11207**

OSCILLATION WAVES OF CHARGE DENSITY IN PLASMA COLUMN. M. Ya. Vasil'eva, A. A. Zaĭtsev, and E. D. Andryukhina (Lomonosov Moscow State Univ.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 995-8(1959) Aug. (In Russian)

A wave-like motion from cathode to anode independent of frequency was observed at low gas pressures in a positive plasma column. Experiments were carried out with discharge tubes filled with helium, argon, and xenon. (R.V.J.)

**11208**

DIFFUSION IN POSITIVE DISCHARGE COLUMN. V. M. Zakharova, Yu. M. Kogan, and V. I. Perel. Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 999-1003(1959) Aug. (In Russian)

A series of correlations derived on the basis of L. Frost's theory (Phys. Rev. 105, 354(1957)) was interpolated with experiments carried out with positive column discharges in Hg, Ar, and Kr. The problem of boundary layer area near the wall was also analyzed. (R.V.J.)

**11209**

ANODE OSCILLATIONS IN LOW PRESSURE DISCHARGE. A. A. Zaĭtsev and K. I. Efendiev (Lomonosov Moscow State Univ.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 1012-16 (1959) Aug. (In Russian)

Oscillations in arc discharges in mercury vapor with liquid cathodes and discharges with oxide cathodes in inert gases were studied in order to determine the interference of anode oscillations in technical applications of ion equipment and in studies of plasma physics. The studies expand the existing concepts of the anode region, which were based on experimentations with fixed anode voltage drops. (R.V.J.)

**11210**

EXPANSION AND SHIFT OF SPECTRAL LINES IN GAS DISCHARGE PLASMA. S. L. Mandel'shtam and M. A. Mazing (Lomonosov Moscow State Univ.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 1017-20(1959) Aug. (In Russian)

Theoretical investigations of interaction processes between an emitting atom and its surrounding field indicate certain correlations for $\gamma$ lines and charged particle concentrations. Line broadening induced by charged particles was studied in an Ar discharge channel at high temperature and high degree of ionization. Measurements were made of the width and shift of forty lines. The results, in strong disagreement with Weisskopf–Lindholm theory, initiated a careful analysis of existing theory and resulted in the development of a non-stationary expansion theory. (R.V.J.)

**11211**

MEASUREMENTS OF ELECTRIC FIELDS IN HIGH-FREQUENCY LOW-PRESSURE DISCHARGE BY ELECTRON BEAM. G. S. Solntsev, A. G. Porokhin, and N. M. Christyakova (Lomonosov Moscow State Univ.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 1026-30(1959) Aug. (In Russian)

The high-frequency field intensity and spatial charge at various discharge intervals were measured simultaneously by the electron beam method. Data were obtained on the distribution of electric fields and spatial charge in argon at $10^{-2}$ mm mercury pressure. (R.V.J.)

**11212**

MEASUREMENTS OF ELECTRIC FIELD IN HIGH FREQUENCY PLASMA. V. E. Mitsuk, M. D. Koz'minykh, and I. V. Talalaeva. Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 1031-5(1959) Aug. (In Russian)

Correlations were made of $H_\beta$ line contour parameters, calculated according to the D. I. Blokhintsev theory, with experimental data obtained in hydrogen at 9400 MHz frequency and 1 mm mercury column pressure. It is shown that the Stark effect can be effectively used in measuring electric fields in microwave plasma. (R.V.J.)

**11213**

INFLUENCE OF AUXILIARY ELECTRODE TEMPERATURE ON THE IGNITION OF HIGH-FREQUENCY DISCHARGE IN HELIUM. Kh. A. Dzherpetov. Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 1036-9(1959) Aug. (In Russian)

The influence of initial electron concentrations on the spark-over intensity was determined by introducing an auxiliary electrode into a discharge tube and varying the initial electron concentration in the discharge region. The experiments indicate that at a certain auxiliary electrode temperature the intensity of ignition drops. However, it then remains constant with temperature increases. (R.V.J.)

**11214**

LOW-FREQUENCY WAVE PHENOMENA IN GLOW DISCHARGE PLASMA. L. Pekarek. Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 1050-2(1959) Aug.

The transmission of small perturbations in discharges with stationary or mobile layers was studied in order to determine the phenomena inducing the appearance and the mobility of discharge layers. The experiments were conducted with rarefied hydrogen. The properties of stationary layers were correlated with those of mobile layers by means of a photomultiplier which was shifted along the discharge tube axis and permitted the observation of perturbation propagation. (R.V.J.)

**11215**

ULTIMATE AND SECONDARY ELECTRON ENERGIES IN THE NEGATIVE GLOW OF A COLD-CATHODE DISCHARGE IN HELIUM. J. M. Anderson (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys. 31, 511-15(1960) Mar.

The "ultimate" electron density in the negative glow plasma of a cold-cathode discharge in helium at gas pressures 3-12 mm Hg was determined by simultaneous Langmuir probe and microwave transmission methods. A correlation is obtained at densities above $\sim 4 \times 10^{11}/cm^3$ when the influence of positive ion scattering of the electrons diffusing to the probe is considered. The ultimate electron temperature in the helium negative glow was measured by the metallic probe to be quite low, ~400°K, and the "secondary" electron temperature was found to be ~50,000°K. These probe indications are substantiated by measurement of the microwave noise power radiated from the plasma which is found to correspond to an effective temperature varying from 300 to ~1000°K. (auth)

**11216**

NUMERICAL CALCULATION OF ABSOLUTE BREMSSTRAHLUNG INTENSITY FOR A FULLY IONIZED FULLY DISSOCIATED HYDROGENIC GAS. G. Sargent Janes and H. Koritz (Avco-Everett Research Lab., Everett, Mass.). J. Appl. Phys. 31, 525-8(1960) Mar.

By using the approximate relationships of Kirkpatrick and Weidmann (Phys. Rev. 67, 321(1945) for bremsstrahlung intensities, numerical calculations were made on the IBM 650 at the Avco-Everett Research Laboratory for a fully ionized, fully dissociated hydrogenic gas. The intensities are given in terms of a quantity having the units ergs/sec/unit frequency interval/steradian/$cm^3$ as a function of hv, (from 0.5 to 4.0 ev) and kT (from 4 to 200 ev). A calibration method was devised for measurement of absolute bremsstrahlung intensities which continually compensates for the errors present in most calibration procedures. (auth)

**11217**

ON THE STABILITY OF AN ELECTRON GAS AT LOW DENSITY. Masao Shimizu (Tokyo Metropolitan Univ.). J. Phys. Soc. Japan 15, 217-19(1960) Feb. (In English)

The stability of an electron gas at low density is discussed on the basis of the energy spectrum of a quasi-particle which was given by the Bohm-Pines theory. (auth)

**11218**

FLOW OF A VISCOUS, ELECTRICALLY CONDUCTING FLUID ALONG A CIRCULAR CYLINDER OR A FLATE PLATE WITH UNIFORM SUCTION. Michiru Yasuhara (Nagoya Univ., Japan). J. Phys. Soc. Japan 15, 321-5(1960) Feb. (In English)

An exact solution of the flow of a viscous, electrically conducting fluid with an externally imposed magnetic field normal to the wall is obtained for the incompressible flow along a circular cylinder or a flat plate with uniform suction. Analytical results show that if the Alfvén wave velocity is smaller than the suction velocity, a physically possible solution is obtained under a given boundary condition, and that the applied magnetic field acts on the flow as a decelerating action as expected from the general property of magnetic force, and as a result of this nature, the coefficient of skin-friction is reduced and that of Maxwell's stress is increased, while the total drag is kept unchanged. The solution reduces to that of the asymptotic suction flow of a non-conducting fluid when the magnetic field tends to zero. (auth)

**11219**

TRANSIENT TEMPERATURE VARIATIONS DURING THE SELF-HEATING OF A PLASMA BY THERMONUCLEAR REACTIONS. Howard D. Greyber (Univ. of California, Livermore). Phys. Rev. 117, 43-4(1960) Jan. 1.

The ion and electron temperature variations in an idealized controlled thermonuclear reactor burning various ratios of deuterium and tritium are calculated. The variation in the fraction of energy deposited to the nuclear and electron gases with temperature is specifically included. One qualitative result is that it would be unsafe to assume nuclear temperature always equal to or greater than electron temperature for a nuclearly reacting plasma with tritium concentration greater than ten per cent. (auth)

**11220**

QUANTUM THEORY OF TRANSPORT IN A MAGNETIC FIELD. Petros N. Argyres (Lincoln Lab., Massachusetts Inst. of Tech., Lexington). Phys. Rev. 117, 315-28(1960) Jan. 15.

A quantum-mechanical theory of transport of charge for an electron gas in a magnetic field is presented that takes account of the quantization of the electron orbits. A transport equation for the necessary elements of the density matrix is developed for arbitrary values of the magnetic field. The scattering is taken to be elastic and is treated only in the Born approximation. The effect of both the magnetic and electric fields on the collisions is taken into account. The influence of the latter was neglected in previous theories. It is proven to be important in high magnetic fields. It is established that the effect of a transverse electric field on the scattering can be described as the tendency of the electrons to "relax" to a distribution characteristic of thermal equilibrium in the presence of the electric field. Previous theories of transport for large Hall angles are consistent with this theory. They can be obtained as a special solution, found by iteration, of this transport equation. The special case of isotropic scattering was considered in detail. In this case it is demonstrated that for small enough magnetic fields the usual classical result obtains. (auth)

**11221**

ELECTRON AND ION RUNAWAY IN A FULLY IONIZED GAS. [PART] II. H. Dreicer (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. 117, 329-42(1960) Jan. 15.

The treatment presented in an earlier paper is extended to give a more exact estimate of the particle runaway rate in a fully ionized gas under the action of a weak applied electric field. By analyzing the motion of particles in various regions of velocity space, it is shown that in any weak applied electric field some particles will always run away. The rate at which this occurs is determined by the flow of particles from the collision-dominated to the electric-field-dominated region of velocity space. The probability, $Q(\tau)$, of electron runaway as a function of time is calculated with the help of the Boltzmann-Fokker-Planck equation and can be expressed in the form $Q(\tau) = 1 - \exp(-\lambda_1\tau)$. The runaway rate, $\lambda_1$, is presented as a function of applied electric field, and the plasma temperature and density. It exceeds by several orders of magnitude the rate recently proposed by Harrison. The runaway rate for positive ions is shown to be exceedingly small compared to $\lambda_1$, in the circumstances usually encountered. A brief discussion is devoted to the experimental evidence, the effects of magnetic fields, and the excitation of plasma instabilities. The correction which particle runaway introduces in the equation of pressure balance is presented for the case of a static pinched discharge. (auth)

**11222**

ELECTRON VELOCITY DISTRIBUTIONS IN A PARTIALLY IONIZED GAS. H. Dreicer (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. 117, 343-54(1960) Jan. 15.

The Boltzmann method is applied to the problem of calculating the electron velocity distribution in a partially ionized gas. Inelastic collisions with neutral molecules as well as random two-body Coulomb interactions are included. The latter are treated by use of the Fokker-Planck equation. Application is made to a hydrogen plasma subjected to an externally applied electric field. Static solutions are obtained, by numerical means, as a function of the ionization degree, and the classical gas discharge parameter, E/p. It is shown that the evolution of the electron velocity distribution function from that characteristic of a poorly ionized gas to the Maxwellian distribution occurs over a very large range in ionization degree. Several applications are made to energy relaxation phenomena, and the electrical conductivity is evaluated. (auth)

**11223**

DEVELOPMENT OF SPACE CHARGE AND GROWTH OF IONIZATION IN THE TRANSIENT TOWNSEND DISCHARGE. Yasunori Miyoshi (Nagoya Inst. of Tech., Japan). Phys. Rev. 117, 355-65(1960) Jan. 15.

By using the general formulas derived from the analysis in a previous paper, calculations are made of the development of electronic and ionic space charges, the growth of space-charge-distorted field, the buildup of current, and the gain in ionization integral due to the field distortion in the transient Townsend discharge. On the basis of these data, two types of Townsend-mechanism spark breakdown are discussed. (auth)

**11224**

RADIO EMISSION BY PLASMA OSCILLATIONS IN NONUNIFORM PLASMAS. D. A. Tidman (Univ. of Chicago). Phys. Rev. 117, 366-74(1960) Jan. 15.

Equations of motion for small-amplitude plasma oscillations interacting with the electromagnetic field in slowly varying density or temperature gradients are set up. The radio noise excited by a wave packet of plasma oscillations traversing such gradients using the WKB approximation is then calculated. A similar calculation is made for a density discontinuity. (auth)

**11225**

PROPAGATION OF PLASMA WAVES ACROSS A DENSITY DISCONTINUITY. Arnold H. Kritz and David Mintzer (Yale Univ., New Haven). Phys. Rev. 117, 382-6(1960) Jan. 15.

The linearized plasma equations and the boundary conditions to be satisfied across a surface of density discontinuity are considered. It is shown that an incident longitudinal plasma wave generates reflected and transmitted transverse plasma waves, as well as reflected and transmitted longitudinal waves. The inverse process also occurs. The transverse waves are generated only when the longitudinal wave is almost normally incident; in the inverse process, the generated longitudinal waves are propagated normal to the boundary. (auth)

**11226**

ELECTRO-HYDROMAGNETIC WAVES IN A FULLY IONIZED GAS. PART I. K. D. Cole (Dept. of External Affairs, Melbourne). Planetary Space Sci. 1, 319-24 (1959) Sept.

Transport equations are used to determine coefficients which are generalizations for any frequency of electric field of the parallel, Pedersen and Hall conductivities in a fully ionized gas. These coefficients are used to investigate the propagation of weak electromagnetic and hydromagnetic waves of all frequencies across a homogeneous and constant magnetic field in a rarefied fully ionized gas. An expression is derived for progagation perpendicular to the magnetic field for all frequencies. Similar relationships are deduced for propagation at any angle to the field for frequencies greater than about 10 times the gyrofrequency of electrons. The theory is applied to the transmission of disturbance across the interplanetary medium, the temperature of the solar corona and the earth's outer atmosphere, the emission of non-thermal solar radio noise, cosmic radio noise, and the anomalous emission of light from shock fronts. (auth)

**11227**

SOME INVESTIGATIONS ON THE PHYSICS OF A HEATED PLASMA AND ITS CONTAINMENT. M. A. Leontovich (Academy of Sciences, USSR). J. Nuclear Energy, Pt. C, Plasma Phys., Accelerators, Thermonuclear Research 1, 3-7(1959) Oct.

A summary of several theoretical and experimental investigations on the physics of a heated plasma and its containment is presented. Experiments include studies of the following: currents in plasma in toroidal chambers with a strong longitudinal magnetic field; a magnetic mirror trap; stability condition for a low pressure plasma; the interchange instability for a cylindrically symmetrical plasma column; stability of plasma of axial symmetry; the influence of finite conductivity on the stability of a pinch in a strong longitudinal magnetic field; the role of impurity radiation in the pinch energy balance; and motion of particles in magnetic traps. (B.O.G.)

**11228**

ESSENTIAL LIMITATIONS AND T—Nt DIAGRAM FOR SELF-SUSTAINING FUSION SYSTEMS. Mitsuo Imoto (Nihon Univ., Tokyo). J. Nuclear Energy, Pt. C, Plasma Phys.—Accelerators—Thermonuclear Research 1, 19-30 (1959) Oct.

Various criteria and essential limitations are shown for any fusion reactor in a unified way. For this purpose, any fusion system is described in terms of two fundamental variables, a new parameter $\tau$ = Nt, called the reduced time, and the temperature T. Differential equations for time variations of the compositions of fuels, as well as the bremsstrahlung loss caused by electron-electron scattering, are introduced into the energy balancing considerations. Maximum and minimum values of T and $\tau$ are found, expressed as two contours enclosing energy balancing regions in narrow and wide senses in T—$\tau$ space, called the T—Nt diagram. These contours include the criteria of Post and Lawson. With the aid of the T—Nt diagram, the ideal temperature to operate reactors, upper limits to efficiencies for available energy gains, two roles played by ashes, the critical time to renew the fuel, the fact that, without effective utilization of neutrons and their energy, pure deuterium fuel cannot be used as a direct energy source, time variations of energy generation and losses, and some other criteria of a technical character are discussed. The T—Nt diagram can be regarded as a strategic chart for fusion projects. (auth)

**11229**

ON THE CONFINEMENT OF CHARGED PARTICLES IN A MAGNETIC FIELD. B. Lehnert (Royal Inst. of Tech., Stockholm). J. Nuclear Energy, Pt. C, Plasma Phys.—Accelerators—Thermonuclear Research 1, 40-8(1960) Oct.

A self-sustained thermonuclear fusion reaction requires a high degree of particle confinement. A ring-shaped solid conductor placed in the interior of the reaction volume produces a strong poloidal magnetic field which traps particles completely, at least at low gas densities. The leads which supply current to the conductor can be arranged in a way such as to prevent particle losses out of the confinement volume. Modifications and improvements of the magnetic field configuration by the addition of auxiliary coils are discussed. Injection of ions into the confinement volume is discussed briefly as well as a number of other possible heating mechanisms. A short consideration of the stability problem is given. (auth)

**11230**

EQUILIBRIUM CONFIGURATIONS OF A TOROIDAL PLASMA. E. W. Laing, S. J. Roberts, and R. T. P. Whipple (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. C, Plasma Phys.—Accelerators—Thermonuclear Research 1, 49-54(1960) Oct.

Equilibrium configurations of a toroidal plasma were obtained, characterized by parameters for the gas pressure and the toroidal component of the magnetic field and by the aspect ratio of the torus. These configurations are symmetrical about the axis of the torus and fall naturally into two classes, corresponding to cases where the toroidal component of the magnetic field either is in the same direction over a cross-section of the torus or changes direction in the center of the cross-section. (auth)

**11231**

CURRENT PAPERS IN PLASMA PHYSICS, ACCELERATORS AND THERMONUCLEAR RESEARCH. J. Nuclear Energy, Pt. C, Plasma Phys., Accelerators, Thermonuclear Research 1, 97-104(1959) Oct.

A bibliography is presented of current publications appearing since January 1, 1959. These papers are concerned with plasma physics, accelerators, and thermonuclear research. (B.O.G.)

**11232**

STRUCTURE OF PERPENDICULAR MAGNETOHYDRODYNAMIC SHOCK WAVE. A. G. Kulikovskii and G. A. Lyubimov. Priklad. Mat. i Mekhan. 23, 1146-7(1959) Nov.-Dec. (In Russian)

Studies were made of the structure of perpendicular shock waves in heat-conducting and electro-conducting but non-viscous media. (R.V.J.)

**11233**

INTERACTION OF AN ELECTRON STREAM WITH PLASMA. E. V. Bogdanov, V. Ya. Kislov, and Z. S. Chernov. Radiotekh. i Elektron. 5, 229-38(1960) Feb. (In Russian)

Interactions of confined electron flux with plasma were analyzed. A dispersion equation was derived and conditions of high-frequency signal buildup are found. Experimental studies were carried out with a modulated electron beam interacting with discharge plasma in a longitudinal field. Amplifications of plasma up to 40∂σ was achieved at tne range from 30 to 3 cm. (R.V.J.)

**11234**

ON THE POSSIBLE EQUILIBRIUM CONFIGURATIONS OF A THIN RING PLASMA CONDUCTOR IN MAGNETIC FIELD. Yu. V. Vandakurov (Inst. of Physics and Tech., Academy of Sciences, USSR). Zhur. Tekh. Fiz. 29, 1312-16(1959) Nov. (In Russian)

The field conditions under which a ring-shaped plasma conductor is found in equilibrium were determined. Configuration of surface currents with the component and volume currents streaming along the conductor was studied. (R.V.J.)

**11235**

ON THE MOVEMENT OF CHARGED RELATIVISTIC PARTICLES IN MAGNETIC FIELD OF DIRECT CYLINDRICAL CURRENT OF DISCHARGED PLASMA. N. I. Shtepa (Orsk State Pedagogical Inst.). Zhur. Tekh. Fiz. 29, 1346-53 (1959) Nov. (In Russian)

Studies were made of relativistic particle motion in magnetic fields of strong, constant, cylindrical, homogeneous density discharge currents. Quadratic correlations were derived for determining radial dimensions of permissible motion, the period of radial oscillations, the rotation period around the symmetry axis, and the mean velocity of particle drift in the axial direction. (R.V.J.)

**11236**

IMPROVEMENTS IN OR RELATING TO GAS DISCHARGE APPARATUS. Peter Clive Thonemann and Robert Carruthers (to United Kingdom Energy Authority). British Patent 830,251. Mar. 16, 1960.

A means is offered for preventing contact of the plasma with its container in toroid thermonuclear reactors. It consists in providing the container with electrically conducting walls of a thickness large compared with the greatest skin depth of eddy currents induced in the walls by movement of the discharge. Deviation of the plasma current from the center of its torus would induce additional circulating eddy currents in the wall and restore the current to the center. The reflection of the current channel by the wall also increases the energy of the positive nuclei. (T.R.H.)

**11237**

IMPROVEMENTS IN OR RELATING TO GAS DISCHARGE APPARATUS. Peter Clive Thonemann, Robert Carruthers, and Roy John Bickerton (to United Kingdom Atomic Energy Authority). British Patent 830,252. Mar. 16, 1960.

A thermonuclear reactor with a toroidal vessel for containing a plasma pinched by magnetic fields from torus windings is described. The device embodies inventions described in patents numbered 830,251, 830,253, 830,254, and 830,256. (T.R.H.)

**11238**

IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF MECHANICAL POWER FROM THERMONUCLEAR REACTORS. Robert Carruthers (to United Kingdom Atomic Energy Authority). British Patent 830,253. Mar. 16, 1960.

A power removal system for thermonuclear reactors is described. An electric motor brings a single-phase alternator, a flywheel, and a three-phase alternator, all on the same shaft, up to speed. The three-phase alternator is connected through a switch to the primary of a transformer, the secondary of which is a ring-discharge apparatus wherein thermonuclear reactions occur. The switch operates to close during some of the output cycles and initiate discharges in the ring. When the switch is closed, the three-phase alternator drives the flywheel and second alternator to produce electricity. (T.R.H.)

**11239**

IMPROVEMENTS IN OR RELATING TO GAS DISCHARGE APPARATUS. Roy John Bickerton (to United Kingdom Energy Authority). British Patent 830,254. Mar. 16, 1960.

A means of reducing spatial instability in gas-discharge tori having thick electrically conducting walls is described. The torus is encircled by two toroidal cores of a pulse transformer with primary windings. The discharge in the torus is the secondary. A former winding on the torus in 16 coils has 716 turns which at 1200 amps (d-c) gives a field of 1000 gauss. This former winding is energized during the period shortly before and shortly after the period of the pulsed torus discharge. The stabilizing action of the axial magnetic field comes from the trapping of its lines of force in the current channel of the torus discharge. (T.R.H.)

**11240**

IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF NUCLEAR POWER. Peter Clive Thonemann, Michael John Poole, John David Lawson, and John Hobbs Tait (to United Kingdom Atomic Energy Authority). British Patent 830,255. Mar. 16, 1960.

The production of useful power from fast neutrons from a toroidal nuclear reactor is described. The reaction chamber is surrounded by a $U^{238}$ layer in which fission occurs. The fission neutrons then react with an outermost $Li^6$ layer to produce T and an additional 10 Mev/neutron. (T.R.H.)

**11241**

IMPROVEMENTS IN OR RELATING TO PRODUCTION OF ELECTRICAL POWER FROM THERMONUCLEAR REACTORS. Robert Carruthers (to United Kingdom Atomic Energy Authority). British Patent 830,256. Mar. 16, 1960.

A method is presented for producing power from a toroidal thermonuclear reactor. A condenser discharges periodically through the gas-filled torus which forms the secondary of a transformer. A second condenser discharges through the primary of the transformer with alternating polarity. Thus the primary current in successive discharges through a switching system always moves in the same direction in the transformer primary. Current is drawn from the condenser-transformer resonant circuit by a rectifier. (T.R.H.)

## Shielding Calculations

**11242** WADC-TN-59-227

Wright Air Development Center. Air Force Nuclear Engineering Test Facility, Wright-Patterson AFB, Ohio. SOME NEW TYPES OF NEUTRON-SHIELDING MATERIALS. Anthony N. Fasano. June 1959. 6p. Project No. 7112. OTS.

Research reported was conducted between 1954 and 1957 at Brookhaven National Lab.

Materials having high neutron-absorption cross sections are needed for protecting gamma and neutron detectors from thermal-neutron damage and to form collimators for beams of neutrons. Boron or lithium, as the powdery compounds $B_4C$ and LiF, could absorb the neutrons, but as powders are impossible to apply or form into protective shields. Processes were developed using inexpensive plastic, paraffin, and linseed oil as bonds and G.E. thinner, Saurizen thinner, trichlorethylene, and turpentine as solvents to produce materials that can be molded, formed, cast, rolled, or painted as a protective shielding or coating. Methods were devised for reclaiming the expensive boron and lithium compounds. (auth)

**11243**

THE EFFECT OF LAYERS WITH BORON CONTENT ON THE SECONDARY GAMMA-RAY YIELD. D. L. Broder, A. P. Kondrashov, A. A. Kutusov, and A. I. Lashuk. Atomnaya Energ. 8, 49-51(1960) Jan. (In Russian)

The influence of a boron carbide layer, placed between steel and Plexiglas (imitating water), on the intensity of $\gamma$ quanta produced was studied in two types of steel, St-3 and stainless steel 1X18H9T. The geometry of the experiment, the spatial distribution of neutrons, and the $\gamma$ spectrum formed are plotted. (R.V.J.)

**11244**

LOW-BACKGROUND SHIELDS. Richard C. McCall (General Electric Co., Richland, Wash.). Health Phys. 2, 304-6(1960) Feb.

A shielded cell around a Na(Tl) crystal scintillation detector is described which was constructed of polyethylene-lined paper bags containing 100 pounds each of crushed talc. The cell was 4 ft × 4 ft × 4 ft with 2-ft thick walls. Background in the talc cell ranged from about 200% at low energies to 160% at high energies of that obtained in a lead cell. The cost of the talc cell was about 20% of that of a lead cell. Use of the cell for counting whole-body gamma radiation in humans is described. (C.H.)

## Theoretical Physics

**11245**

PROBABILISTICALLY INTERPRETABLE FIELD THEORIES WITH AN INDEFINITE METRIC. K. L. Nagy (Inst. for Theoretical Physics, Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung. 11, 193-9(1960). (In English)

Methods of constructing "physical" S-matrices are investigated in field theories with an indefinite metric which are not immediately probabilistically interpretable. Procedures are proposed leading to physical S-matrices through equations which make possible the probabilistical interpretation for each time instant. The physical S-matrices thus constructed, however, do not fulfil the causality requirement. (auth)

**11246**

Q-NUMBER COMMUTATION RELATIONS AND PHYSICAL CONTENT OF A SIMPLE FIELD THEORY. G. Herber (Universität, Jena, Ger.). Acta Phys. Polon. 18, 581-7 (1959). (In German)

It is shown that there exist q-number-commutation relations with the following properties: they are relativistically invariant and microscopically causal; the physical content of the isolated field is as usual, especially particles as eigenstates of the field; and the field interacts with other fields unconventionally. These facts are proved for a real scalar field with rest-mass zero. (auth)

**11247**

MANY-BODY PROBLEM IN QUANTUM STATISTICAL MECHANICS. III. ZERO-TEMPERATURE LIMIT FOR DILUTE HARD SPHERES. T. D. Lee (Columbia Univ., New York) and C. N. Yang (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. 117, 12-21(1960) Jan. 1.

Using the method developed in paper I of this series, the thermodynamical properties at T = 0 of a dilute system of hard spheres are computed for small values of $\rho a^3$, where a is the diameter of the spheres and $\rho$ is the particle density. (auth)

**11248**

MANY-BODY PROBLEM IN QUANTUM STATISTICAL MECHANICS. IV. FORMULATION IN TERMS OF AVERAGE OCCUPATION NUMBER IN MOMENTUM SPACE. T. D. Lee (Columbia Univ., New York) and C. N. Yang (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. 117, 22-36 (1960) Jan. 1.

Starting from Rules A and B of a previous paper (I), it is shown that the grand partition function can be evaluated in terms of the statistical averages of the occupation number in momentum space. The final formulation is in terms of a simple variational principle. The procedure represents a concise and complete separation of the effect of the Bose-Einstein or Fermi-Dirac statistical character of the particles from the dynamical problem. In the case of Bose statistics, this formulation makes possible a systematic computation of all thermodynamic functions near the Bose-Einstein transition point in the gaseous phase. Applications to a system of hard spheres are discussed. (auth)

**11249**

SINGLE PARTICLE ENERGIES IN THE THEORY OF NUCLEAR MATTER. K. A. Brueckner and D. T. Goldman (Univ. of Pennsylvania, Philadelphia). Phys. Rev. 117, 207-13(1960) Jan. 1.

The excitation spectrum of real and virtual excitations is discussed from the point of view of the perturbation series expansion. The effect of the rearrangement energy terms in the single-particle virtual excitation spectrum is evaluated and seen to be very small. It is noted that the virtual particle energies are real due to the effects of off-energy-shell propagation. Starting from the reaction matrix approximation for the ground state energy, the energies of real particle and hole excitations are defined which satisfy the separation energy theorem. It is shown that the energies so defined depend on an infinite sequence of terms giving the rearrangement energy for multiple excitations. Appropriate termination and evaluation of this series are discussed. (auth)

# REACTOR TECHNOLOGY

## General and Miscellaneous

**11250** ACNP-5910

Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee. ALLIS-CHALMERS CRITICAL FACILITY. Final Safeguards Report. C. B. Graham. May 1, 1959. 146p. For Northern States Power Co. Contract AT(11-1)-589. OTS.

The A-C Critical Facility Reactor will be used as an aid in the nuclear design of the CRBR. The reactor is cylindrical, heterogeneous, unpressurized, and water moderated. The core is composed of two regions, a superheater mockup in the center surrounded by an annular boiler region mockup. The fuel elements in the superheater region will be of fully enriched $UO_2$—stainless steel cermet, clad with stainless steel. The fuel elements in the boiler region will be slightly enriched $UO_2$ clad with Al. The most severe credible accident was found to be the startup accident. (W.D.M.)

**11251** AEEW-R-4

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England.
AUTO-CONTROL EXPERIMENTS ON DIDO USING DISCONTINUOUS FEEDBACK. L. A. J. Lawrence. Dec. 1959. 41p. BIS.

Experiments on auto-controlling the DIDO Reactor are described and the equipment design is discussed in some detail. The experiments are carried out to show the suitability of an on/off type of control for the maintenance of a constant flux level in the presence of noise and constant period during power change. The controlling signals stem from measurement of neutron flux computed to give deviation from demanded power, and period, respectively. These signals are fed to a d-c amplifier with variable deadband whose output is used to control relays, these in turn control the coarse control arms by means of three-phase motors. The system is designed on the basis of locus diagrams, a conventional non-linear technique being used to handle the relay performance. Calculation of the reactor transfer function at high and low power respectively shows that the stability margin is not appreciably affected by the inherent thermodynamic feedback in the reactor core. (auth)

**11252** AERE-C/R-2855
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE RESULTS OF RADIATION CHEMICAL MEASUREMENTS DURING THE EARLY OPERATIONAL PERIOD OF DIDO. A. R. Anderson and W. R. Marsh. Nov. 1959. 26p. (BIS).

The results of chemical experiments carried out during the DIDO start-up period are reported. Measurements on the rate of decomposition of the heavy water, the efficiency of the Baker-Platinum Recombination Unit, and the rate of formation of nitric acid are given. (auth)

**11253** AERE-R-3153
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
PHYSICS MEASUREMENTS DURING THE COMMISSIONING OF PLUTO; NEUTRON FLUX DISTRIBUTIONS. C. J. England and S. B. Wright. Nov. 1959. 90p. BIS.

Neutron flux distributions in the core and experimental holes of PLUTO are given. The principal sources of uncertainty in the fluxes in the reactor during normal operation are discussed. A typical set of figures for the unperturbed reactor operating at 10 Mw thermal power are quoted. (auth)

**11254** ANL-6132
Argonne National Lab., Lemont, Ill.
NUMERICAL SOLUTION OF THE ONE-GROUP SPACE-INDEPENDENT REACTOR KINETICS EQUATIONS FOR NEUTRON DENSITY GIVEN THE EXCESS REACTIVITY. J. J. Kaganove. Feb. 1960. 15p. Contract W-31-109-eng-38. OTS.

The advantages and shortcomings of the codes currently in use at Argonne (RE-13 and RE-129) are discussed. A new method of solution, which has increased accuracy, stability for exceptionally large integration intervals, and a procedure for automatically changing the integration interval as the nature of the problem changes, is developed. (auth)

**11255** CEA-1196
France. Commissariat à l'Énergie Atomique, Paris.
CONTROLE DE LA PUISSANCE D'UNE PILE PAR LA MESURE DE L'ACTIVITE DU FLUIDE DE REFROIDISSEMENT CAS PARTICULIER DE EL 3. (Control of Pile Power by Measurement of the Activity of the Cooling Fluid. The Particular case of EL3). J. Lalere. May 1959. 20p.

In a high flux pile the presence of local absorbers makes the power difficult to measure. In any case thermodynamic measurements are sometimes not very accurate. Another possible method would be the measurement of the cooling fluid activity. This was tried on the heavy water circuit of EL3. Some qualitative indications of the various activities present in the heavy water in circulation are given. The activity of the element chosen was calculated. The results obtained from EL3 are also given. (auth)

**11256** CF-60-3-3
Oak Ridge National Lab., Tenn.
PROCEDURE FOR TESTING REACTOR CONTROLS PULSE AMPLIFIER AND PREAMPLIFIER. J. L. Anderson. Mar. 3, 1960. 11p. OTS.

Circuit description and procedure are presented for testing and operating reactor control amplifier and preamplifier. (auth)

**11257** GEAP-3204
General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.
METAL—WATER REACTIONS. IV. HEAT TRANSFER CONDITIONS DURING SEVERE NUCLEAR EXCURSIONS IN WATER COOLED REACTORS. K. Hikido. Sept. 15, 1959. 21p. Project No. 1. Contract AT(04-3)-189. OTS.

Analytical results and test reactor experiments have indicated that the initial power pulse of a nuclear excursion severe enough to produce fuel melting and possible metal—water reaction can be completed in less than 250 milliseconds. Analyzing heat-transfer under such rapidly changing conditions is a difficult problem. This report presents a review of pertinent transient heat-transfer data to form a basis for indicating the influence of heat-transfer on the course of a severe nuclear excursion. A previously developed method for analyzing the heat-transfer phenomena during an excursion in a water cooled and moderated reactor is reviewed with this background to evaluate possible improvements in the models. It is concluded that at the present state of development of the method of analysis as it is applied to the study of metal-water reactions, a more refined heat-transfer model and more precise input data are not warranted. In the future, as the study progresses, requirements on the heat-transfer model are expected to become more stringent. To obtain a more sophisticated and refined analysis, particularly during the nucleate-boiling regime, additional analytical and experimental work will be required. Indication of the available information in the literature and the direction future analytical and experimental effort might proceed are presented. (auth)

**11258** HW-58932
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
OXYGEN SCAVENGER STUDIES WITH HYDRAZINE IN HIGH pH SYSTEMS. Interim Report. L. D. Perrigo, Jr. and T. F. Demitt. Jan. 20, 1959. 7p. OTS.

A study was made to determine the feasibility of using hydrazine to scavenge dissolved oxygen from the high pH KER loops during periods of out-of-reactor operation. Secondary objectives were aimed at determining the ultimate concentration levels of the hydrazine decomposition products, $NH_3$ and $H_2$. Hydrazine is being investigated for this application since the reactants and the decomposition products are all gaseous compounds; hence no solids will be added to or formed in the loop. The results indicate that oxygen scavenging is both rapid and complete when hydrazine is present in the loop water at from 1 to 20 ppm and the oxygen concentration is not greater than 1.0 ppm. (W.L.H.)

**11259** IDO-16572
Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.
DOUBLE P-1 SPHERICAL HARMONICS APPROXIMATION IN SLAB GEOMETRY. D. R. Metcalf and G. A. Cazier. Mar. 4, 1960. 31p. Contract AT(10-1)-205. OTS.

Reactor physics calculations on heterogeneous reactors where fuel elements are of the plate type often make necessary a study of the local thermal flux variation. The purpose of such a study is to obtain proper flux-weighted thermal constants for a homogeneous core or a cell of a core. In the past such studies have been done by the $P_3$ standard spherical harmonics approximation to the transport equation. A greatly improved technique is applied to slab geometry where the angular flux is expanded in half-range Legendre polynomials rather than the full range polynomials. This method simplifies calculation techniques considerably in that much fewer terms are needed in the expansion to obtain adequate accuracy as compared to the standard spherical harmonics method. Modifications are made in the original $P_3$ program to use the half-range method and other extensions are made to make the program more useful and general. (auth)

**11260** LA-2161(Suppl.)
Los Alamos Scientific Lab., N. Mex.
A ONE DIMENSIONAL INTERMEDIATE REACTOR COMPUTING PROGRAM. Forrest Brinkley. May 1959. 88p. Contract W-7405-eng-36. OTS.

Modifications were made to the one-dimensional multi-lethargy group, multiregion intermediate reactor code programmed for the IBM-704. Flexibility was added to the code by including neutron thermal velocity distribution (speed-up), inelastic scattering, variable (energy dependent) extrapolation distance, the variable geometric buckling approximation for bare reactors, and re-start conditions. With the modifications to the code, a reactor can be computed with a variable delta radius and the lethargy dependent values can be loaded on line. Provisions were included to enter any desired tabulation of neutron energy or lethargy groups, fission spectrum, and neutron cross sections. A tape table was added so that the lethargy value is used to select the proper microscopic tape for cross sections. A cell calculation can be made for the multipoint calculations. A sample output of the code is contained. (C.J.G.)

**11261** NAA-SR-4780
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
FLUX HARDENING IN FUEL RODS. E. U. Vaughan. Mar. 15, 1960. 16p. Contract AT-11-1-GEN-8. OTS.

Assuming an isothermal Maxwellian flux spectrum in the moderator, a correction to the diffusion theory estimate of thermal utilization of a reactor cell was calculated to account for the hardening of the neutron flux as it diffuses into the fuel rod. In representative cases the thermal utilization and, through it, the multiplication factor are reduced by about 0.6%—an amount which may be significant in careful critical mass estimates. (auth)

**11262** NAA-SR-Memo-4625
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
A REACTOR WITH TEMPERATURE COMMUTATION. W. A. Horning. Nov. 6, 1959. 6p. OTS.

A device which illustrates temperature commutation, i.e., pulsed heating of each point on a rotating wheel in such a manner that the temperature at a selected point remains higher than would be feasible with steady heating of each portion, is described. The concept is applied to a rotating wheel coated with a uranium glaze bounded on one side by a stationary moderating material in the form of a circular arc which covers about 60° of the wheel's rim. Parameters of uranium integrity during operation, spalling of support material, critical mass, fission gases, choice of coolant gas, and design of energy converter are considered. (J.R.D.)

**11263** NAA-SR-Memo-4665
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
GEOMETRIC BUCKLING OF A BARE TRUNCATED SPHERE. Dean P. Gamble. Nov. 17, 1959. 9p. OTS.

The geometric buckling of the truncated spherical water boiler core decreases with rise of water level due to void formation in an excursion. A first-order computation for buckling is presented along with a second-order correction term. It is pointed out that in the absence of a rigorous solution for buckling of the truncated sphere, accuracy must be inferred from the extrapolation precision at the end points. The concept appears to have uses for limited shape perturbations of simple solids. (J.R.D.)

**11264** NAA-SR-Memo-4928
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
CHANGE OF KEWB REACTOR CORES—EVALUATION OF SIGNIFICANCE WITH REGARD TO ASSOCIATED HAZARDS. Feb. 4, 1960. 139p. OTS.

The KEWB Facility is described, and an over-all technical evaluation is made of the hazards associated with changing from a spherical to a cylindrical core. The characteristics of the two systems, the operation and emergency procedures, a brief history of the program, a summary of the data obtained, and maximum accident analyses are given. The conclusion is that the core change does not represent an adverse change with respect to associated hazards. (T.R.H.)

**11265** NP-8401
Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw.
SPEKTR GAMMA IZLUCHENIYA IZ GORIZONTAL'NOGO KANALA REAKTORA. (Gamma Spectrum of Radiation from Horizontal Channel Reactor). Report No. 121/1-A. A. Yasinskiĭ and Ya. Kovnatskiĭ. Nov. 1959. 8p.

The $\gamma$ spectrum was measured in the range of energy 30 to 1600 kev. Several repeated measurements showed on the background of the continuous spectrum several groups of $\gamma$ lines in the region of 0.1, 0.2, 0.4, 0.7, and 1.5 Mev. The results were compared with the predicted form of the spectrum, computed from known probabilities of mass distribution of fission products. (auth)

**11266** ORNL-2464
Oak Ridge National Lab., Tenn.
ART REMOVAL AND DISASSEMBLY. A. A. Abbatiello and F. R. McQuilkin. Mar. 18, 1960. 126p. Contract W-7405-eng-26. OTS.

A study of a high-level-activity hot cell for the major dissection of the ART was made. Such dissection was necessary to obtain metallurgical and design data on which future high-performance reactors might be based. The study included severing and removing the reactor from the test cell after operation, a procedure for a component removal sequence, and a proposed disassembly building facility. Evaluations of handling, measuring, and cutting techniques for remote work are presented. Although these are based on limited experimental work, progress is adequate to indicate their potential value for any high-level reactors which must be handled after irradiation. In many cases details of the work in the form of the original report have been included in the Appendix. With the termination of the ART project in September 1957, the draft for what was to have been a status report was revised to become this termination report. Thus, the plans and experimental work are recorded for those who may find the information useful on similar problems. (auth)

**11267** ORNL-2809
Oak Ridge National Lab., Tenn.
AN IBM-704 CODE FOR A HARMONICS METHOD APPLIED TO TWO-REGION SPHERICAL REACTORS. R. Chalkley, C. W. Nestor, Jr., and M. L. Tobias. Mar. 15, 1960. 17p. Contract W-7405-eng-26. OTS.

An IBM-704 computer code for the harmonics method of criticality calculation for two-region spherical reactors is described. In the harmonics method, the criticality condition corresponds to the vanishing of a certain infinite-order determinant; in practice, this condition is replaced by equating a finite-order approximating determinant to zero. By hand, the calculations can be performed conveniently only for second-order approximating determinants. The approximating determinant with the described code is customarily of the seventh order. Losses of significant figures prevented the use of larger determinants. The machine running time per case is generally about 30 sec. (auth)

**11268** SCTM-276-59(12)
Sandia Corp., Albuquerque, N. Mex.
AN APPROXIMATE STUDY OF THE PERFORMANCE OF A REACTOR-HEAT EXCHANGE SYSTEM. B. Wilcox. Aug. 10, 1959. 147p. OTS.

The coolant temperatures at the inlet and outlet of a reactor and connected heat exchange units are determined for variations in coolant flow parameters. In addition, the power regulation of the reactor is determined for these variations under several conditions of fuel loading. Equilibrium conditions are assumed. (auth)

**11269** SCTM-383-59(12)
Sandia Corp., Albuquerque, N. Mex.
AN EXPERIMENTAL STUDY OF THE COOLANT FLOW DISTRIBUTION WITHIN THE TURRET REACTOR CORE. Bruce Wilcox. Dec. 10, 1959. 37p. OTS.

The results of coolant flow studies using a one-third scale model of the turret reactor core are presented. These results are correlated with an approximate analytical method for predicting the flow distribution. Two core geometries are shown such that either a uniform or a cosine-shaped flow distribution is obtained. (auth)

**11270** SRIA-17
Stanford Research Inst. Poulter Labs., Menlo Park, Calif.
CONTAINMENT OF FRAGMENTS FROM RUNAWAY REACTOR. Technical Report No. 3. G. B. Huber, D. D. Keough, M. P. Stallybrass, and N. R. Zabel. Oct. 30, 1959. 100p. Project No. 2. Contract AT(04-3)-115. OTS.

The possible production of and protection from missiles that might result from a reactor runaway was investigated. Scope of the investigation includes experimental and theoretical studies of missile penetration, development of energy sources which will simulate reactor excursions on a small scale, and experiments to evaluate effects of simulated energy release on modeled reactor components. (W.L.H.)

**11271** TID-7571(p.187-92)
Consumers Public Power District, Lincoln, Neb.
THE HALLAM NUCLEAR POWER FACILITY AS A RADIATION SOURCE FOR COMMERCIAL PROCESSING. Emerson Jones. 6p.

The construction of a sodium graphite reactor at Hallam, Nebraska, has introduced the possibility of operating a commercial gamma radiation facility in the center of the food producing area of the United States. The radiation facility would be operated as a by-product of the fundamental objective of electric power production from the reactor system. The paper describes the power plant and radiation facility. (auth)

**11272** TID-8200(Rev.1)
[Division of Reactor Development, AEC].
NUCLEAR REACTORS BUILT, BUILDING, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 31, 1959. 24p.

Information is given about facilities built, building, or planned in the US, which are capable of sustaining a chain reaction. The reactions are categorized primarily by function or purpose: civilian, military, production, export, power, and propulsion. (W.D.M.)

**11273** WAPD-MRJ-9
Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.
REACTOR PHYSICS AND MATHEMATICS TECHNICAL PROGRESS REPORT FOR THE PERIOD DECEMBER 1, 1959 TO MARCH 1, 1960. 100p. Contract AT-11-1-GEN-14. OTS.

Reactor Experiments. The thermal utilization, resonance escape probability, and the relative fission rates of $U^{235}$, $Pu^{239}$, and $Pu^{241}$ were measured in a 1.3% enriched assembly of uranium rods with a metal-to-water volume ratio of 1 : 1. Initial values of the neutron decay constant in pure water as a function of buckling were obtained. The thermal diffusion length was measured in a cadmium-poisoned water solution to be 1.766 ± 0.004 cm. Measurements were completed of the $O^{16}(n,p)N^{16}$ cross section at 14.7 Mev. Reactor Theory and Design Methods. A few-group thermal neutron model was developed and compared with a multigroup method with encouraging results. Although the agreement is not exact, it was found that a three-group scheme yields substantially more accurate flux distributions and eigenvalues than the one-group model. It was also determined that the fortuitous accuracy of the one-group method in calculating rod worths carries over into the three-group scheme. A digital program was developed which will calculate the combined few-group thermal and few-group fast diffusion model in one space dimension. The development of a P-3 model adequate for shielding calculations and for two-dimensional reactor calculations continued. A method was developed to decrease the statistical variance substantially in the two-dimensional Monte Carlo program used in nuclear design. An improved cross section fitting scheme was developed for use in long-life depletion programs. Reactor Kinetics and Control. The development of an analytical model for the simulation of reactor transient behavior including the effects of boiling continued. A stability analysis of the variable coupling core was completed which shows that although the control region has a positive temperature coefficient of reactivity, the over-all negative temperature coefficient assures stability. The space-time equations, including nonlinear terms associated with xenon buildup, were set up and solved on the analog computer for a uniform ring reactor. In the cases calculated, the effect of the nonlinearity is to limit the amplitude of the peak flux and to cause a precession of the isoflux contours around the central axis of the core. A criterion was developed for reactor stability with respect to xenon spatial oscillations. Radiation Analysis. Slant penetration factors for 5.11 Mev gamma rays in iron were calculated and compared with existing data. Buildup factors for 6 Mev gamma rays in iron-water laminations were computed. Mathematics and Digital Computation. An improved acceleration method, the modified Chebyshev semi-iterative technique, was developed which will increase the rate of convergence of the inner iterations in the multidimensional neutron diffusion equations. A more general formulation of the difference form of the biharmonic equations was developed which includes additional boundary conditions of interest in engineering design problems. The difference equations were formulated so that they can be solved by adaptations of many of the numerical techniques developed for the neutron diffusion equation. ABRAC, a three-dimensional nuclear thermal iteration digital program for boiling reactor design, is in the final stages of preproduction testing. An initial version of the Operator System for the Philco-2000 was placed in operation. The two-dimensional neutron diffusion program for the Philco-2000 (PDQ-4) was completed and a number of test problems run successfully. The major nuclear design programs, MUFT, KATE, WANDA, CANDLE, and TURBO, have been largely completed and require only final checkouts on the full 32,000-word Philco-2000 when it is installed at Bettis. The Philco-2000 digital computer, scheduled for delivery to Bettis, successfully completed individual performance tests but did not run at high enough efficiency in extended production trials to warrant acceptance by Bettis. Detailed debugging, particularly on the magnetic tape units and the input-output processor, is continuing at Philco. (For preceding period see WAPD-MRJ-8.) (auth)

**11274** WAPD-T-753
Westinghouse Electric Corp. Bettis Plant, Pittsburgh.
FAST ABSORPTION OF HAFNIUM AND CADMIUM-SILVER CONTROL RODS. Robert J. Neuhold. Oct. 1958. 13p. Contract AT-11-1-GEN-14. OTS.

Presented at the American Nuclear Society Meeting, December 8-10, 1958, Detroit, Michigan.

Calculations were made for a highly-enriched, many-rodded, approximately cylindrical core yielding effective fast absorption cross sections of 0.13 ± 0.01 $cm^{-1}$ and 0.169 ± 0.015 $cm^{-1}$ for cadmium-silver (30-70 wt.%) and hafnium control rods, respectively. The general method of obtaining $\Sigma_A^F$ involved the use of a two-dimensional diffusion theory code (PDQ) and measured axial bucklings in both the rodded and unrodded core sections. For each of the two types of rods, several two-group PDQ problems were solved in the rodded section to obtain a plot of the eigenvalue versus $\Sigma_A^F$. The value for the fast absorption of the control rods was taken as that value which gave the same eigenvalue as found for the unrodded core section. The values for $\Sigma_A^f$, which were obtained for control rods operating in a bank, have proven effective in two-dimensional shutdown analyses, rod programmed configurations associated with this core, and one-dimensional, two-group control rod analyses. (auth)

**11275** WCAP-1408
Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.
MULTI-REGION REACTOR LATTICE STUDIES QUARTERLY PROGRESS REPORT FOR THE PERIOD OCTOBER 1, TO DECEMBER 31, 1959. Ira H. Coon. Jan. 30, 1960. 14p. Contract AT(30-1)-2176. OTS.

Progress is briefly summarized on critical experiments, nuclear analysis of multi-region reactor cores, and multi-region core design studies. (For preceding period see WCAP-1404.) (W.L.H.)

**11276**
PERFORMANCE OF MAGNETITE BED FILTERS. C. F. Paulson (Westinghouse Electric Corp., Pittsburgh). Chem. Eng. Progr. 56, No. 3, 64-8(1960) Mar.

The performance of a hot axial flow magnetite bed filter in removing insoluble corrosion products from pressurized water reactor coolant is described. Results of filter performance with respect to crud loading, hours of service, and pressure drop are tabulated. The filters performed equally well in neutral water and in water containing LiOH or $NH_4OH$. The filter removed some radioactivity that would pass through a filter paper. Optimum operating conditions for the hot axial flow magnetite bed filter are given. Cold axial flow magnetite filters were found to remove crud effectively but have a higher pressure drop than hot filters and were subject to plugging. (C.J.G.)

**11277**
REMOVAL OF MOLTEN SODIUM FROM REACTOR COOLANT SYSTEMS. Louis Silverman and Robert A. Sallach (Atomics International Div., North American Aviation Inc. Canoga Park, Calif.). Ind. Eng. Chem. 52, 231-42(1960) Mar.

A method for the removal of molten sodium from oxygen-free inaccessible locations in reactor coolant systems by flotation with HB-40 (a liquid hydrogenated terphenyl) is described. Butyl alcohol, under nitrogen pressure, is used to remove small amounts of sodium adhering to the stainless steel surface. (C.J.G.)

**11278**
A UNIFIED THEORY OF INTERACTION FOR TWO ARBITRARILY MIXED MULTI-GROUP ARRAYS SET IN WELL-DEFINED AND RANDOM REFLECTORS. R. T. Ackroyd, E. J. Burton, and M. A. Perks (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Nuclear Energy, Pt. A, Reactor Sci. 11, 57-68(1960) Feb. (In English)

An interaction theory is given for calculating space arrays of fissile units of arbitrary size, shape, and distribution which uses the same core and reflector constants as are employed in ordinary reactor calculations for single units. Mixed arrays of fast and thermal units are considered. The reflecting material between units may be well defined or random in distribution. A comparison with experiment suggests that the theory is reasonably accurate and errs on the side of safety. Unlike Monte Carlo methods, the method presented requires trivial computation (10 seconds per case computing time on a medium-size computer). Unlike the interaction parameter method, it does not require an experiment on a simple assembly of units before a prediction for a complicated array can be made. (auth)

**11279**
THE DYNAMIC BEHAVIOR OF BOILING WATER REACTORS. J. A. Fleck, Jr. (Univ. of California, Livermore). J. Nuclear Energy, Pt. A, Reactor Sci. 11, 114-30(1960) Feb. (In English)

Using the laws of conservation of mass, energy, and momentum stated in integral form, it is possible to derive a set of ordinary differential equations governing the hydrodynamics of natural circulation boiling systems. The variables which can be determined as functions of time by solving these equations are the water velocities at the inlet and outlet of the heated section, the outlet void fraction, and the total fluid momentum. The effect of a layer of water above the convection circuit also can be taken into account. When these equations are added to the reactor kinetics equations, the equations governing the transfer of heat from reactor fuel elements to water, and the relation between reactivity and the average void fraction, one obtains a model for the dynamic behavior of a boiling water reactor. Calculations made using this model indicate that under certain conditions boiling water reactors can operate stably even for very substantial reactivity additions. Further analysis reveals that under proper conditions purely hydrodynamic instability can occur independently of any coupling between void and power. The onset of this unstable behavior would be independent of nuclear and thermal parameters although the ensuing dynamic behavior of the reactor would depend on them. (auth)

**11280**

THE WORLD'S REACTORS. Nuclear Power 5, No. 45, 86a(1960) Jan.

A chart is presented classifying the world's reactors by moderator under the following types: power reactors and prototypes, power reactor experiments, high power research reactors (over 5000 kw), and low power research reactors. Charts are given showing those reactors under construction, critical, and definitely planned. A comparison of national programs is made. (C.J.G.)

**11281**

ANALOGUE COMPUTERS IN REACTOR ENGINEERING AND SIMULATOR AT THE CZECHOSLOVAK INSTITUTE OF NUCLEAR PHYSICS. M. Krejči, M. Melichar, and M. Zikán. Nukleonika 4, 505-21(1960). (In Polish)

The basic principles of analog computers as used in reactor engineering for the design of reactors and their control devices are discussed. The basic equations for the circuits of a simple computer are given. (C.J.G.)

**11282**

COOLING OF REACTORS. G. Spinnler. Reaktor Bull. No. 9, 1-8(1959) Dec. (In French)

In the fission of a $U^{235}$ nucleus approximately 180 Mev is released as kinetic energy of the nuclear fragments. The fragments collide with the adjacent uranium atoms of the fuel elements and transfer their kinetic energy to the lattice. The energy released in the fission appears therefore as oscillatory energy of the uranium atom of the fuel, that is, as heat. The nuclear fragments originating in the fission emit intensive radiation. The radiation is absorbed for the most part in the construction material of the reactor. Heat therefore appears so that the reactor must be cooled. This fact means complicated apparatus so that the cooling will be maintained under all conditions. The power of a reactor is limited by the fuel element temperature, heat stress, and other factors. The cooling system must therefore be planned in the construction of a reactor. There are various cooling systems. Water, heavy water, gas, liquid metal, or an organic liquid can be used as the reactor coolant. The coolant system of the DIORIT is described as an example. (tr-auth)

**11283**

FUEL ELEMENTS (URANIUM CLAD WITH ZIRCONIUM) PRODUCED BY CO-EXTRUSION. R. Montagné, A. Winogradzki, C. Sauve, and J. Buffet. Rev. mét. 55, 1073-8(1958). (In French)

A description is given of a process for making fuel elements for atomic reactors. Contact of the most intimate possible kind is achieved between the fuel and the sheath by the simultaneous extrusion of the two elements. Genuine welding between the two metals is thus effected. This can be subsequently improved by a heat-treatment which causes diffusion. Tests made on these co-extruded elements are described. (auth)

**11284**

NUCLEAR REACTOR CONTROL. (to U. S. Atomic Energy Commission). British Patent 829,427. Mar. 2, 1960.

A reactor control system is described. Approach to criticality is detected by periodically varying the reactivity at a predetermined frequency large compared to the reciprocal of the period of delayed neutrons but small compared to the reciprocal of the period of prompt neutrons and measuring the prompt neutron fraction. The multiplication factor is controlled by this measurement by suitable electronic and mechanical means which are described. (T.R.H.)

**11285**

ATOMIC POWER PLANTS HAVING HETEROGENEOUS NUCLEAR REACTORS. (to Sulzer Frères Société Anonyme). British Patent 829,676. Mar. 2, 1960.

A steam-turbine nuclear power plant system is described. Heat from the moderator cooling loop is transferred to feed liquid preheaters. These preheaters are separated by a preheater heated by tapped vapor from the steam turbine. The amount of tapped vapor is reduced to the minimum required for removing moisture from the turbine, thus giving a thermal efficiency gain for the plant. (T.R.H.)

## Power Reactors

**11286** ACNP-5915

Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee. PATHFINDER ATOMIC POWER PLANT TECHNICAL PROGRESS REPORT [FOR] APRIL 1, 1959–JUNE 30, 1959. Aug. 15, 1959. 119p. Contract AT(11-1)-589. OTS.

Annealing, corrosion, and irradiation testing of aluminum base double alloy fuel elements were conducted. Interdiffusion anneals at 500°F for periods up to 83 days were accomplished. Heat transfer and fluid flow studies of the heat transfer loop, boiler fuel elements, and the water moderator in the superheater region are discussed. Progress on fuel element fabrication is reported. Welding tests were conducted on the reactor vessel shell and the final design is presented. Progress on the fabrication, installation, and testing of recirculation pumps, steam separators, control rods, guide tubes, and control rod drives is reported. An analysis of control rod worths, core burn-up, boiling effects in superheater, and shielding of fuel handling building is given. A description of the reactor burn-up and decay code (BAD), which has been programmed for the IBM-704, is given. The filter test loop and the radioactive gas decontamination system are described. Instrumentation and control features of the plant are discussed. A plant safety analysis is given. (For preceding period see ACNP-5909.) (C.J.G.)

**11287** ACNP-5920

Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee. PATHFINDER ATOMIC POWER PLANT COOLANT DISTRIBUTION TESTS. Final Report. J. Wilson and R. Styles. Nov. 15, 1959. 24p. For Northern States Power Co. and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. OTS.

Tests were made to determine the head loss coefficient through the inlet plenum of the Pathfinder reactor and to determine the flow distribution among the fuel element nozzles for various operating conditions—with all three pumps operating at the same flow rate and with any combination of only two pumps operating at the same flow rate. A quarter-scale wooden model was used for the tests. Air was used as the fluid. The loss coefficient was determined to be 1.8 ± 0.3. The velocities of flow through the fuel element nozzles were determined to be within ±5 per cent of average flow when all pumps are operating and within ±10 per cent of average flow when only two pumps are operating. (auth)

**11288** BAW-1158

Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.

CRITICAL EXPERIMENTS WITH GENERAL ELECTRIC COMPANY FUEL FOR THE N. S. SAVANNAH. R. M. Ball, A. L. MacKinney, J. H. Mortenson, and H. F. Johnston. July 27, 1959. 79p. Contract AT(30-1)-2340. OTS.

Experimental data are tabulated as obtained from comparative measurements using fuel rods provided by the General Electric Company together with The Babcock and Wilcox MARTY pins. Both sets of fuel elements were clad with stainless steel and contained uranium dioxide enriched to 4% U-235. The results provide critical configurations and data for determining reactivity effects of spacer bars (flow blocks), reactivity effects of thick-walled fuel rods and corner poison rods, flux distributions in the G.E. fuel, differential water worths, reactivity effects of rod followers, and temperature effects. (auth)

**11289** CRRP-872
Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.
THE EFFECT OF FLUX FLATTENING ON THE ECONOMICS OF HEAVY WATER MODERATED REACTORS. W. J. Henderson and D. G. Hurst. Dec. 1959. 83p. (AECL-949). AECL.

The effects of reflector thickness on reactors with non-uniform cores were considered. The changing ratio of fast to slow neutron flux near the boundary is taken into account and an analysis of reactors containing zones with various rod spacings and irradiations is presented. A cost estimate for reactor power output is included. Those considered are large heavy water moderated natural uranium fueled cylindrical reactors. It was found that a high degree of radial power flattening in a cylindrical reactor can be obtained by using two concentric core zones which differ only in irradiation. The burnup loss from flattening is a function of rod type and reactor size, and the cost benefit resulting from flattening depends on the rod type. (J.R.D.)

**11290** DL-39
Atomic Energy of Canada Ltd., Chalk River, Ont.
NEUTRON ECONOMY. W. B. Lewis. Feb. 1960. 12p. (AECL-975). AECL.

The relation of economic nuclear power to neutron economy is pointed out, and specific simplified examples of cost evaluation are chosen to illustrate the value of the concept in nuclear design. (T.R.H.)

**11291** DP-445
Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.
HEAVY WATER MODERATED POWER REACTORS PROGRESS REPORT [FOR] NOVEMBER 1959. R. R. Hood and L. Isakoff, comps. Dec. 1959. 48p. Contract AT(07-2)-1. OTS.

At the end of November, 20% of the construction and 80% of the firm design of the Heavy Water Components Test Reactor (HWCTR) were complete. Proof testing of various seals and mechanisms for the HWCTR continued satisfactorily. Further analyses are given of the transient behavior of the HWCTR isolated coolant loops and of the experimental data on the nuclear effects of hot moderator. The results of additional fabrication and irradiation tests of uranium metal and uranium oxide are recorded. The manufacture of tubular metallurgical joints between Zircaloy and stainless steel is also reported. (See also DP-415.) (auth)

**11292** DP-455
Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.
HEAVY WATER MODERATED POWER REACTORS. Progress Report for December 1959. R. R. Hood and L. Isakoff, comps. Jan. 1960. 37p. Contract AT(07-2)-1. OTS.

At the end of 1959, 25% of the construction and 85% of the firm design of the Heavy Water Components Test Reactor (HWCTR) were complete. Further safeguards analyses of the HWCTR, done with the aid of analog and digital computers, corroborated earlier data which indicated that the reactor is highly self-regulating, and that the safety system should prevent release of radioactivity outside the containment building. Fabrication tests of metallic uranium fuels and preparation of irradiation specimens of swaged uranium oxide fuel tubes continued. A tube of Zircaloy-2-clad U–2 wt.% Zr failed during a low temperature, low pressure irradiation test to modest exposure. Preliminary examinations of tubular metallurgical joints between Zircaloy and stainless steel were promising. (For preceding period see DP-445.) (J.R.D.)

**11293** FICO-112
Ford Instrument Co., Long Island City, N. Y. and Maryland Shipbuilding and Drydock Co., Baltimore.
NUCLEAR PROTOTYPE POWER PLANT INSTALLATION IN MERCHANT SHIPS. Feb. 1960. 154p. Contract MA-1893. OTS.

Several methods by which nuclear prototype power plants can be pre-tested and installed in merchant ships are presented, and their general application to the construction and conversion of the basic classes of ships is evaluated. The effects of test site locations, reactor test programs, reactor test vehicle towing procedures, etc., are also evaluated. An optimum technique concept is applied to a reference 32,790 dwt tanker and gas/superheated steam nuclear power plant, and the concept developed in sufficient detail to yield over-all gross cost estimates, production schedules and safety features. The test site requirements, reactor test program, and hazards evaluation are presented. (auth)

**11294** GA-744
General Atomic Div., General Dynamics Corp., San Diego, Calif.
MARITIME GAS-COOLED REACTOR PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1958. 111p. Contract AT(04-3)-187. OTS.

The MGCR program objectives are to develop and construct a land based prototype of a high-temperature nuclear reactor, coupled with a closed-cycle, gas-turbine system for maritime application. The first broad task undertaken by the MGCR program was a detailed study and evaluation of the various coolants and moderators which could be considered as realistic possibilities for this application. The evaluation program led to the selection of a graphite moderator and helium coolant as being the most feasible and having the greatest possibilities of leading to a reliable high performance power system. Development work is proceeding rapidly in the areas of materials development, reactor design, turbomachinery, and design and development of plant fluid and electrical systems and other components thereof. Two fuel element concepts under development are (1) a heterogeneous, rod-bundle element consisting of $UO_2$ bodies dispersed through an oxide diluent and encased in metal capsules and (2) a semihomogeneous fuel-moderator element consisting of metal-clad cylindrical fuel bodies inserted in graphite plates. Studies of the compatibility of metals with graphite in the temperature range 1500 to 1700°F were made. Nuclear analysis refined the estimates of nuclear performance given previously. Particular emphasis was placed on the control requirements, control-rod worth, and neutron thermalization in graphite. Design analysis of the concentric-duct piping led to the design of experiments on model ducts. Considerations of critical-speed and bearing problems of the turbomachinery and over-all cycle efficiency led to the conclusion that the MGCR plant cycle must definitely have intercooling to meet the desired performance. (See also GA-570.) (W.D.M.)

**11295** GA-1030
General Atomic Div., General Dynamics Corp., San Diego, Calif.
MARITIME GAS-COOLED REACTOR PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING MARCH 31, 1959. 118p. Contract AT(04-3)-187. OTS.

Turbomachinery considerations indicated that it would be desirable to reduce the cycle pressure from 1,000 to 800 psia. The problem of determining the temperature distribution and the resulting thermal stress pattern within the graphite was considered. Preliminary designs for a heterogeneous fuel element and a semihomogeneous fuel element were developed. Utilization of the Hanford in-pile gas loop for fuel element testing is discussed. Two-group PDQ calculations were run to estimate control rod worth for the preliminary design core under cold, clean conditions. Curves of rod worth versus position were developed for the hot, clean and the cold, clean preliminary design core. A detailed lifetime calculation was made for the preliminary design heterogeneous core. Fuel cycle costs were estimated on the basis of the effect of B in the fuel elements. The schedule and facilities for the critical experiments are discussed in some detail. The speed of the main turbine shaft was tentatively set at about 12,200 rpm. The design and fabrication of a test stand to evaluate shaft seals and seal systems were completed and trial runs were made. The effects of minor heat transfer due to heat leakage, fluid flow, and thermodynamic phenomena on MGCR full-load cycle performance were studied. Operating characteristics of the heat exchanger test facility are described. A critical review was conducted on the desirability of using concentric ducts and valves. Block diagrams outlining reactor power level, outlet temperature, and plant inventory control are presented. Equations which permit the dynamic analysis of a closed-cycle gas-turbine plant were programed for a digital computer. Descriptions were prepared for fluid-mechanical systems. Several methods of purifying He in both storage bank and main loop were investigated. Investigations into the maximum operating temperatures of the various electrical equipment indicate that temperatures up to 140°F can be tolerated. Preliminary design work was carried out on an emergency cooldown system which uses a stored inert coolant. Work on the irradiation stability of fuel materials indicated that conversion from the monocarbide to the dicarbide can take place at 2,350°F in graphite bodies containing UC. Densities as high as 96.6% theoretical were obtained in alumina pellets sintered in H. Xenon released from irradiated $UO_2$ granules was measured. Progress was made in the development of high-temperature x-ray-diffraction techniques. Tests were conducted to investigate the effects of coolant and impurities in the coolant on plant materials and the effects of gettering on inhibiting reactions. Economic studies were continued with the objective of determining the optimum size and power ranges for both nuclear and conventionally powered ships. (For preceding period see GA-744.) (W.D.M.)

**11296** NAA-SR-3575
NAA-SR-Memo-4048
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
PRELIMINARY SAFEGUARDS REPORT FOR THE PIQUA ORGANIC MODERATED REACTOR (REVISED). J. Jacobson, ed. Apr. 13, 1959. 290p. SUPPLEMENT I TO THE PRELIMINARY SAFEGUARDS REPORT FOR THE PIQUA ORGANIC MODERATED REACTOR (REVISED). July 1, 1959. 39p. Contract AT-11-1-GEN-8. OTS.

These two reports were issued separately, but are cataloged as a unit.

The plant will operate at power levels up to 45.5 thermal megawatts and is designed to deliver steam to the existing turbine-generator facilities of the Piqua Municipal Power Station. All accidents were analyzed which were considered pertinent to the safety of the plant and to those outside of the controlled area surrounding the site. Only one type of credible incident studied resulted in melting of a portion of the reactor core. This incident assumes an uncontrolled and continuous withdrawal of the reactor control rods during startup of the reactor. Other types of incidents examined cause temperature, power, or pressure transients in the reactor but do not result in melting of the fuel. Incidents involving release of fission products to the environment were also analyzed. Containment of radioactive fission products in the plant is provided by three successive enclosures. Supplement one answers several questions raised by the Reactor Hazards Evaluation Branch of the Atomic Energy Commission in regard to the Piqua Organic Moderated Reactor. (W.L.H.)

**11297** NAA-SR-4239
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
SELECTION OF THE PIQUA OMR FUEL ELEMENT. E. B. Baumeister and J. D. Wilde. Mar. 15, 1960. 35p. Contract AT-11-1-GEN-8. OTS.

Two types of aluminum-clad uranium alloy fuel elements, a square (parallel flat plate) and a circular (concentric cylindrical shell) were investigated to determine their relative suitability for use in the Piqua Reactor. Nuclear, thermal, and mechanical data are given, and considerations leading to selection of the circular element are presented. Design dimensions are listed and reactor thermal design and operating conditions are given for the proposed element. (auth)

**11298** NAA-SR-Memo-2044
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
SUMMARY REPORT ON OMR MARITIME R AND D SHIELDING STUDIES FROM MARCH 11, 1957 TO JUNE 30, 1957. D. S. Duncan and H. O. Whittum. July 31, 1957. 46p. OTS.

A method for achieving optimization of the Maritime OMR shield based on fast neutron removal theory is presented. A comparison of fluxes obtained using this method with the results of experimental measurements performed in the BSR and STR shields indicates that the method can achieve sufficient accuracy in the hydrogenous portions of a shield, but fails in the non-hydrogenous regions. Although it is recommended that other methods should be investigated in future neutron penetration methods studies, it is concluded that the methods developed can achieve reasonably accurate preliminary shield optimization with a minimum of effort, a virtue which adds further impetus to their utilization. (auth)

**11299** NAA-SR-Memo-2073
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
OMR NUCLEAR PARAMETER SURVEY. W. W. Davis and W. D. Leggett. Aug. 20, 1957. 27p. OTS.

A parameter survey was conducted on the Organic Moderated Reactor (OMR) to determine the nuclear effect of temperature, enrichment, fuel to moderator volume ratio, fuel element size, and fuel element container variation. Temperatures ranged from 300 to 700°F; enrichments from 1.5 to 1.9%; and fuel to moderator volume ratios from 0.1333 to 0.545. Fuel element sizes of 3.75, 4.5, and 5.5 in. were considered. The stainless steel fuel element container thickness was varied from 20 to 60 mils, and also 200 mil aluminum was substituted for the steel. Results were obtained as values of $k_{eff}$ which ranged from 0.927 to 1.152 through 150 problems. It was concluded that fuel element size should be at least 4.5 inches, fuel to moderator volume ratio in the neighborhood of 0.30, and enrichment 1.7% assuming 8% excess k for poisoning, burnup, and control. (auth)

**11300** NAA-SR-Memo-2217
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
STAINLESS STEEL CLAD FUEL FOR THE OMR. W. Leggett. Oct. 25, 1957. 16p. OTS.

A study was conducted to determine the reactivity in the OMR for varying enrichments, temperatures, and fuel volume fractions using stainless steel for fuel cladding and structural material. Similar calculations were made for cases in which aluminum is used in place of stainless steel. Results and recommendations are included. (J.R.D.)

**11301** NAA-SR-Memo-3417
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
PRELIMINARY STUDY OF SHIELD COOLING TUBE SPACING. W. C. Burke and J. Vanderlip. Dec. 19, 1958. 11p. OTS.

The cooling tube spacing for cooling the biological shield in the Piqua Power Reactor was investigated. (W.L.H.)

**11302** NAA-SR-Memo-3735
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
PIQUA OMR—SPACING OF CAVITY LINER COOLING PIPES. S. Yee. Apr. 10, 1959. 10p. OTS.

A study was conducted to determine the spacing of the cavity liner cooling pipes for maintenance of a maximum concrete temperature of 150°F in the biological shield. Results and recommendations are given along with descriptions of equipment, methods, and calculations. (J.R.D.)

**11303** NAA-SR-Memo-4259
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
SUMMARY OF CREEP TESTS ON THE PIQUA OMR FLAT-PLATE FUEL ELEMENT. C. R. Davidson and S. Bair. Aug. 12, 1959. 23p. OTS.

The Piqua OMR design specifies a 750°F maximum surface temperature for the Al cladding on the fuel plates. The possibility existed that fuel element failure might occur as a result of creep of the cladding which could obstruct the flow channels. Test fuel elements were suspended in circulating coolant for periods up to 718 hrs at temperatures to 800°F. No evidence of creep was found. (W.D.M.)

**11304** NAA-SR-Memo-4296
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
COOLING OF PIQUA OMR SOURCE ELEMENT. D. J. McGoff. Aug. 26, 1959. 12p. OTS.

The temperature distribution in the Piqua neutron source and the orifice size required to limit the coolant velocity around the source capsule to 3 fps were determined. (W.D.M.)

**11305** NAA-SR-Memo-4341
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
PIQUA OMR PLANT STEADY-STATE CONTROL PROGRAM. W. Kushan. Oct. 14, 1959. 14p. OTS.

The Piqua OMR plant steady-state control program is determined. The steady-state errors in hot leg temperature and boiler organic flow rate which give the maximum permissible steam pressure steady-state deviations at the main steam header are also determined. The required sensitivity of the control subsystems for reactor outlet temperature and steam pressure is derived. (W.D.M.)

**11306** NAA-SR-Memo-4421
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
COOLANT RADIOACTIVITY IN THE CNA-OMR. C. A. Goetz and M. F. Huntsinger. Sept. 29, 1959. 21p. OTS.

The normal radioactivity and associated radiation levels in the primary coolant and in the waste disposal system were determined. The maximum exposed fuel area that can be tolerated without exceeding the $\text{MPC}_a$ at the stack for fission products was also investigated. (W.L.H.)

**11307** NAA-SR-Memo-4426
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
POWER DISTRIBUTIONS AND CONTROL ROD ANALYSIS. J. Hume and M. P. Aronchick. Oct. 9, 1959. 29p. OTS.

The power distribution over a core radial plane was determined for eight combinations of control rod insertions. The maximum peak-to-average factors are tabulated. Factors which control the power distribution over the Piqua Core are discussed and analyses of control rods are given. (J.R.D.)

**11308** NAA-SR-Memo-4435
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
ANALOG STUDY OF PIQUA STEAM GENERATOR DYNAMICS. W. Kushan. Sept. 30, 1959. 52p. OTS.

The transient and frequency response characteristics of the Piqua steam generator were determined. The basic organic flow control subsystem requirements were investigated. An analog model for study of the integrated steam generator and boiler flow control subsystem was developed. Linearized equations to aid interpretation of the planned transient studies were also developed. (W.L.H.)

**11309** NAA-SR-Memo-4593
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
OMR PIQUA WASTE GAS TREATMENT SYSTEM, PROTOTYPE SYSTEM DESCRIPTION AND EXPERIMENTAL PROGRAM. H. M. Gilroy and J. H. Wilson. Nov. 16, 1959. 9p. OTS.

The full-scale experimental prototype of the Piqua Waste Gas Treatment System which was constructed at the Organic Laboratory at Santa Susana is described. The experimental program objective for the initial three months of operation is also presented. (W.L.H.)

**11310** NAA-SR-Memo-4750
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
PRELIMINARY EVALUATION OF THE MECHANISM OF FUEL ELEMENT FOULING. P. Shroff and C. Goetz. Dec. 14, 1959. 19p. OTS.

It was found that a film formed on the heat transfer surface of stainless steel clad fuel elements in OMRE after 1500 hr operation. An investigation was conducted to gain understanding of the formation mechanism. A detailed analysis of results is given. (J.R.D.)

**11311** ORNL-2796

Oak Ridge National Lab., Tenn.
EXPERIMENTAL MOLTEN-SALT-FUELED 30-Mw POWER REACTOR. L. G. Alexander, B. W. Kinyon, M. E. Lackey, H. G. MacPherson, J. W. Miller, F. C. Vonder-Lage, G. D. Whitman, and J. Zasler. Mar. 24, 1960. 35p. Contract W-7405-eng-26. OTS.

A preliminary design study was made of an experimental molten-salt-fueled power reactor. The reactor considered is a single-region homogeneous burner coupled with a Loeffler steam-generating cycle. Conceptual plant layouts, basic information on the major fuel circuit components, a process flowsheet, and the nuclear characteristics of the core are presented. The design plant electrical output is 10 Mw, and the total construction cost is estimated to be approximately $16,000,000. (auth)

**11312** ORNL-2890

Oak Ridge National Lab., Tenn.
MOLTEN-SALT REACTOR PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING OCTOBER 31, 1959. Mar. 8, 1960. 79p. Contract W-7405-eng-26. OTS.

*Engineering and Component Development*. Development work on molten-salt-lubricated bearings was continued. Two pumps equipped with hydrodynamic bearings were bench tested and then tested in molten salt. No evidence of self-welding was found between INOR-8 surfaces immersed in molten salt at 1200°F. Construction of the Remote Maintenance Demonstration Facility, including the viewing equipment, was completed. Eleven long-term corrosion loops completed one year of operating time in this quarter. Tests on two INOR-8 loops and one Inconel loop were terminated for metallurgical examination; the results are not yet available. The PKP centrifugal pump with Fulton Sylphon bellows-mounted seal has logged 17,878 hr of operation in NaK at 1200°F. The MF-type centrifugal pump is operating in a region of cavitation in salt 30, and service time of more than 20,000 hr has been recorded to date. Trouble-free operation of the small frozen-lead pump seal continued. An apparatus for testing graphite-metal seals is under construction. Sectioning of the first two in-pile loops was completed, and metallographic and analytical examinations are in progress. The viscosity of the fuel mixture BULT-14 ($LiF-BeF_2-UF_4-ThF_4$) was determined in the temperature range from 550 to 800°C. Enthalpy measurements with the BeLT-15 mixture ($LiF-BeF_2-ThF_4$) yielded a heat capacity varying from $0.343\ Btu \cdot lb^{-1} \cdot (°F)^{-1}$ at 1000°F to $0.304\ Btu \cdot lb^{-1} \cdot (°F)^{-1}$ at 1500°F. The apparatus for measuring the thermal expansion coefficient, $\beta$, of molten salt mixtures was tested by using HTS ($NaNO_2-NaNO_3-KNO_3$). Preliminary results were obtained for heat transfer with BULT-14 flowing in heated Inconel and INOR-8 tubes. *Materials Studies*. In an effort to join graphite to graphite and graphite to metal for molten-salt reactor service, an alloy (48% Ti–48% Zr–4% Be) was developed and had satisfactory wetting and flowing characteristics. However, because of its poor corrosion resistance to molten fluorides, other alloy systems are being investigated. Promising alloys in the Au-Ni-Ta system are under study, and alloys in the Ni-Nb, Ni-Mo, Ni-Nb-Mo, Ni-Nb-Ta, Pd-Ni-Ta, and Pd-Ni-Mo systems are being prepared for testing. Preliminary work in electric-resistance brazing of graphite to graphite, using molybdenum as the brazing alloy, has also been undertaken. The second of three INOR-8 corrosion inserts was removed after 10,000 hr from an INOR-8 forced-convection loop. Fifteen grades of graphite were classified according to their resistance to permeation by molten fluorides at 150 psig at 1300°F in 100-hr tests. Tests are being conducted to determine to what extent the bismuth-permeated graphite will pick up salts during standard permeation tests. When held in direct contact with graphite for 20 hr at 1300°F, $LiF-BeF_2-UF_4$ apparently gettered completely the oxide contaminants in the graphite. No precipitation was detected radiographically in the $LiF-BeF_2-ThF_4-UF_4$ after it had been in contact with graphite for 500 hr at 1300°F in a vacuum. INOR-8 specimens showed no metallographic indications that carburization had occurred after being in contact with TSF graphite at 1000 psi for 700 hr in salt environment at 1300°F. Four braze materials showed good resistance to fuel 130 ($LiF-BeF_2-UF_4$) during a 5000-hr corrosion test in a thermal-convection loop with a 1300°F hot-leg temperature. Corrosion tests of 100-hr duration indicated that the usefulness of titanium-, zirconium-, or beryllium-containing brazing alloys in fuel 130 would be limited in pure nickel or INOR-8 containers at 1300°F. Heavy attack due to the transfer of the refractory material to the nickel or INOR-8 container walls was observed. Detailed description of the ten subsidiary binary and ternary systems incorporated in the $LiF-BeF_2-UF_4-ThF_4$ quaternary system is nearly completed. The identification of the isomorphic compounds $NaF \cdot BeF_2 \cdot 3UF_4$ and $NaF \cdot BeF_2 \cdot 3ThF_4$ is of especial academic interest since $NaF \cdot BeF_2 \cdot 3UF_4$ has been erroneously reported in the literature as $NaF \cdot 4UF_4$. Exchange reactions in molten fluorides are being explored. The diffusion of chromium, which is the rate-limiting process for long-term corrosion in molten fluoride breeders, is strongly dependent on grain size, and hence on annealing history. Under equivalent conditions there is no significant difference between the diffusion coefficients of chromium in INOR-8 and in Inconel; thus the steady-state corrosion rate is predicted to be higher by a factor of 15/7 in Inconel, since this is the ratio of chromium concentration in the two alloys. Exploratory studies on the hygroscopicity of fuels and on the possibility of drying at low temperatures without extensive hydrolysis have given additional qualitative evidence of the extreme sensitivity of the fuels to moist air. Evidence of formation of a graphite intercalation compound with $MoF_6$ was found, but this compound is not expected to be encountered in reactor operation. Several grades of extruded graphite, but none of the molded types, show less than 1 vol.% permeation by breeder fuels at 60 to 75 psig and 1300°F. About 740 kg of purified fuel mixtures were processed during the quarter. Modification of the hydrofluorination-volatilization process is being investigated for application to thorium-bearing fuel salts, a principal objective being the retention of the processed material in the fluoride form. The solubility of $ThF_4$ in hot aqueous ammonium fluoride solutions is as high as 4 to 5%, and this system is therefore being investigated further. The use of $ClF_3-HF$ mixtures does not appear feasible because of the suppression of LiF solubility and the correspondingly low $UF_4$ and $ThF_4$ solubilities. The $NO_2-HF$ system is also unattractive because of the low solubility of $ThF_4$, although that of $UF_4$ is higher. (For preceding period see ORNL-2799.) (auth)

**11313** TID-5613

Duquesne Light Co., Shippingport, Penna.
CONTROL ROD DRIVE MECHANISM PERIODIC TEST. SECTION I. TWELFTH PERFORMANCE. CORE I, SEED I. Test Results DL-S-148 (T-550011). First Issue, Feb. 25, 1960. 11p. OTS.

Studies were made to determine the operating conditions of the control rod drive mechanisms. All control rod drive mechanisms functioned satisfactorily during the performance of this test. Several control rods scrammed while being withdrawn to a height of 69 in. during the minimum running current test; however, these control rods were successfully withdrawn later by increasing the stator current. The data obtained during the performance of this test agree closely with the data obtained in the previous performances. (W.L.H.)

**11314** TID-5614
Duquesne Light Co., Shippingport, Penna.
STATION RADIATION LEVEL SURVEY. SECTION III. FIRST PERFORMANCE. CORE 1, SEED 1. Test Results DL-S-157. First issue, Feb. 9, 1960. 11p. OTS.

A test was made to determine the level of the radiation field and the contamination in the non-nuclear portions of the Station after the reactor had been shut down. All radiation and contamination levels throughout the non-nuclear portions of the Station were found to be background. All smear contamination was of the beta-gamma type. No alpha or neutron radiation was detected during the test. (W.L.H.)

**11315** TID-5615
Duquesne Light Co., Shippingport, Penna.
MAIN UNIT HEAT RATE TESTS. SECTION I. THIRD PERFORMANCE. CORE 1, SEED 1. Test Results DL-S-176. Test Performed Aug. 27, 1959. 20p. OTS.

The main unit heat rate for various loads was determined. The data taken on March 19 and 20, 1959, indicate that the heat rates, within the limits of accuracy of the involved instrumentation, were as predicted by the turbine generator contract. (W.L.H.)

**11316** TID-5616
Duquesne Light Co., Shippingport, Penna.
PERIODIC RADIATION SURVEY OF REACTOR PLANT CONTAINER AND COMPONENTS AFTER SHUTDOWN "C" SURVEY. SECTION III, 5735.8 EFPH. FIFTH PERFORMANCE. CORE 1, SEED 1. Test Results DL-S-184 (T-612076). First issue, Feb. 25, 1960. 6p. OTS.

Tests were conducted to assay the changes in radiation level in the PWR purification system 1BD Hairpin Loop resulting from continued operation of the reactor at power. It was found that the radiation in this component decays to a tolerable level one minute after isolation of the loop; prior to isolation the radiation level was 250 to 300 mr/hr. (J.R.D.)

**11317** TID-5617
Duquesne Light Co., Shippingport, Penna.
CAPPED VALVE AND D/P CELL VENT TEST. SECTION II. FIRST PERFORMANCE. CORE 1, SEED 1. Test Results DL-S-189(T-612109). First issue, Feb. 25, 1960. 6p. OTS.

Test were conducted to determine if sufficient clearance exists around the vent of each PWR reactor plant Bailey D/P cell to accommodate a minimum of one venting adapter. It was found that at least one of the three available adapters can be used to vent all reactor plant Bailey D/P cells except the two FEDAL flow D/P cells, one blanket assembly flow D/P cell, and one seed assembly flow D/P cell. (J.R.D.)

**11318** TID-5618
Duquesne Light Co., Shippingport, Penna.
REFUELING SEAL TO REACTOR VESSEL HEAD. SECTION I. CORE 1, SEED 1. Test Results DL-S-194(T-612111). First issue, Feb. 25, 1960. 4p. OTS.

A test was conducted to test the PWR refueling seal for leaks with the reactor pit water levels at 1, 5, 10, 15, 20, and 25 feet. No leaks were found. (J.R.D.)

**11319** TID-5619
Duquesne Light Co., Shippingport, Penna.
CONTROL AIR CONDITIONS AT THE REACTOR CHAMBER. SECTION II. Test Results DL-S-269. First Issue, Feb. 16, 1960. 14p. OTS.

The gas leakage rate from the rod drive stator and position indicator housings while pressurized at 1, 2, and 3 psig was determined. A leak rate of 12 to 14 cfm was obtained when all mechanism housings were simultaneously pressurized to 3 psig. The leakage in each mechanism was relatively uniform as shown by the data obtained when the mechanisms were pressurized to 3 psig in groups of four. Although the rate varied slightly from group to group, it was ~2 cfm per group. (W.L.H.)

**11320** TID-5649
Duquesne Light Co., Shippingport, Penna.
EXAMINATION OF COMPONENTS FOR CRUD AND CORROSION. SECTION I. FIRST PERFORMANCE. CORE I, SEED I. Test Results DL-S-155 (T-612080). First issue, Jan. 19, 1960. 16p. OTS.

Investigations to establish the extent and location of corrosion, crud deposits, and defects in components of the 1D reactor coolant pump are reported. Minor pits found on the impeller assembly contained $Fe^{59}$, $Co^{58}$, $Co^{60}$, $Cr^{31}$, $Hf^{181}$, and $Zr^{95}$. Radiochemical analytical data are included. (J.R.D.,

**11321** TID-5650
Duquesne Light Co., Shippingport, Penna.
RADIOACTIVE WASTE DISPOSAL SYSTEM PERIODIC RADIATION MONITORING SURVEY. SECTION II. CORE I, SEED I. Test Results DL-S-169 (T-612075). First issue, Dec. 15, 1959. 17p. OTS.

Investigations to determine the radiation level at all monitored points in the radioactive waste disposal area and the effectiveness of shielding facilities in working areas during which the radiation level is above the approved limit of 5 mr/hr. It was found that the level in all areas was below the limit. (J.R.D.)

**11322** TID-5651
Duquesne Light Co., Shippingport, Penna.
MAIN UNIT HEAT RATE TESTS. SECTION I. SECOND PERFORMANCE. CORE I, SEED I. Test Results DL-S-176. Second issue, Jan. 4, 1960. 23p. OTS.

An investigation to obtain the PWR main unit heat rate under various load conditions is described. Calculations based on test data indicate that the heat rates are as predicted in the turbine generator contract. Test data are included. (J.R.D.)

**11323** TID-5652
Duquesne Light Co., Shippingport, Penna.
PERIODIC RADIATION SURVEY OF REACTOR PLANT CONTAINER AND COMPONENTS AFTER SHUTDOWN "B" SURVEY. SECTION II. THIRD PERFORMANCE. CORE I, SEED I. Test Results DL-S-184 (T-612076). First issue, Dec. 23, 1959. 14p. OTS.

Tests were conducted to determine radiation intensity at welds, thermowells, and major components in the loops when the reactor is subcritical following an extended power run. Radiation levels were generally low; however, a small increase was noted over the second performance. (J.R.D.)

**11324** TID-5653
Duquesne Light Co., Shippingport, Penna.
PERIODIC RADIATION SURVEY OF REACTOR PLANT CONTAINER AND COMPONENTS AFTER SHUTDOWN "B" SURVEY. SECTION II. FOURTH PERFORMANCE. CORE 1, SEED 1. Test Results DL-S-184 (T-612076). First issue, Dec. 21, 1959. 18p. OTS.

Tests were conducted to determine the radiation levels around the PWR coolant purification system heat exchangers. The radiation levels were generally low in the boiler chamber, and the levels at all monitored points decreased to low levels during the fifteen hour test period. (J.R.D.)

**11325** TID-5654
Duquesne Light Co., Shippingport, Penna.
RADIATION SURVEY OF REACTOR PLANT CONTAINERS AND COMPONENTS AFTER SHUTDOWN "D" SURVEY. SECTION III. FIRST PERFORMANCE. CORE 1, SEED 1. Test Results DL-S-184 (T-612076). First issue, Dec. 31, 1959. 7p. OTS.

A test was conducted to determine the amount of radioactive crud buildup in the 1AC hairpin loop and to determine the time required for this radiation level to decrease to a steady-state value after shutdown. Results are presented graphically and a log of shutdown events is included. (J.R.D.)

**11326** TID-5663
American Electric Power Service Corp., New York.
ECNG-FWCNG GAS-COOLED REACTOR PROJECT PROGRESS REVIEW MEETING, DECEMBER 15, 1959. R. B. Finn, Jr. and L. F. Smith. 21p. OTS.

Conceptual design, reactor physics, and experimental program progress is reported. Construction schedules are given. (T.R.H.)

**11327** TID-5664
Duquesne Light Co., Shippingport, Penna.
FUEL HANDLING CRANE AND EXTRACTION TOOL. SECTION I. CORE 1, SEED 1. Test Results DL-S-304-S (RNI-35). First issue, Jan. 4, 1960. 5p. OTS.

A test was made to correlate various elevations of the extraction tool head with the tool head height indicator readings. It was determined from the data obtained that the height indicator readings varied for the same tool head elevation depending upon whether the tool head was raised or lowered to this elevation. Downward travel versus upward travel of the tool-post to same elevation deviated by 0.1 to 0.14 inches as read on the height indicator. (W.L.H.)

**11328** TID-5686
Atomic Power Development Associates, Inc., Detroit.
SPECIFICATION FOR FIXED IN-PLANT RADIATION MONITORING FOR THE ENRICO FERMI ATOMIC POWER PLANT. Specification 708. G. C. Burkitt and J. J. Owens. Aug. 26, 1959. 27p. (APDA-Spec-70-8). OTS.

Requirements are given for furnishing, designing, erection, field adjustment, and preliminary operation of the fixed in-plant radiation monitoring systems for the Enrico Fermi Atomic Power Plant. (W.D.M.)

**11329** TID-8520
Division of Reactor Development, AEC.
THE NUCLEAR ROCKET: NEW POWERPLANT FOR SPACE VEHICLE PROPULSION. Howard R. Schmidt and Ralph S. Decker. Mar. 1960. 41p. OTS.

Prepared for presentation at the American Power Conference sponsored by the Illinois Institute of Technology, Chicago, Illinois, March 29, 1960.

A fundamental and practical survey is made of nuclear rocket application to space vehicle propulsion. The engine is described and propellant and radiation effects are discussed. Project Rover is summarized and performance requirements for a space vehicle are discussed. It is concluded that nuclear rockets can provide substantial performance, reliability, and economic advantages for difficult space missions. (T.R.H.)

**11330** TID-10090
Division of Reactor Development, AEC.
REACTOR INFORMATION MEETING, ARGONNE NATIONAL LABORATORY, OCTOBER 7, 8, 9, 1953. II. REACTOR PHYSICS; CRITICAL AND EXPONENTIAL EXPERIMENTS MEASUREMENTS. Decl. Jan. 4, 1960. 52p. OTS.

Eleven papers on reactor calculations for various types of lattices and calculational methods in reactor physics are presented. (T.R.H.)

**11331** YAEC-62
Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.
PHYSICS CALCULATIONS FOR CONTROL RODS IN THE FIRST YANKEE CORE. William Howard Arnold, Jr. Sept. 1959. 49p. For Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. OTS.

The calculation of control rod worths in light water moderated reactors is presented. Considerable experimental information from the Yankee critical experiments is discussed and applied to improve the theory. The calculation system thus deduced from theory and experiment is then applied to the final design of the first Yankee core to provide a prediction of the shutdown available in its control rods. These calculations show that the 24 control rods presently provided are sufficient to shut the hot, clean, zero power first core down by 3%. (auth)

**11332** YAEC-130
Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.
WCAP-4 IN-PILE TEST LOOP DESIGN MANUAL. C. Dishman. Jan. 1960. 133p. For the Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. OTS.

The mechanical and electrical system design features of the WCAP-4 in-pile test loop are described. This loop was designed for testing Yankee Power Reactor materials in nuclear, chemical, thermal, and hydraulic conditions. (T.R.H.)

**11333** YAEC-145
Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.
CAT—AN IBM 704 PROGRAM FOR COOLANT ACTUATED TRANSIENTS IN AN OPEN-LATTICE CORE. L. S. Tong, J. P. Cunningham, A. Bournia, R. R. Stephenson, and M. B. Newman. Feb. 1960. 80p. For Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. OTS.

The CAT (Coolant Actuated Transients) Code was developed for using an IBM-704 Electronic Data Processing Machine to calculate the coolant actuated transients in a reactor core during a loss of coolant flow accident. The fuel geometry is an open lattice of identical vertical cylindrical rods uniformly spaced and the coolant flows parallel to them. For purposes of analysis, two types of channels are defined: one is the "hot channels" which are assumed few in number and to which the hot channel factors are applied, and the other is the "normal channels" which are effectively infinite in number. Thus the flow in the normal channels is not influenced by any flow redistribution from the hot channels. Because the opening between the rods connecting the hot and normal channels is much larger than the cross sectional flow area of the channel, the radial pressure gradient is considered negligible in comparison with the axial pressure gradient. The coolant flow rate in the hot channel is determined stepwise by equalizing the pressure drops of the small axial sections of the hot channels and the normal channels. (auth)

**11334** YAEC-151
Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.
NEUTRON FLUX PEAKING AND POWER SHAPES: A COMPARISON OF THEORY AND EXPERIMENT. Robert A. Dannels and Walter J. Eich. Oct. 1959. 32p. For Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. OTS.

An experiment designed to measure neutron flux peaking in a reactor core due to the presence of a water slot is described. Results of two and one dimensional analyses of the experiment using various calculational procedures are given. The experimental results are well matched by the MUFT-SOFOCATE-Diffusion theory method. Extension of the one dimensional analysis is made to a typical water slot encountered in a hot Yankee core. Power shapes were also measured in various other configurations within a Yankee critical lattice involving combinations of control rods and/or control rod followers. In general, power traverses derived from two-dimensional analyses match experimental points. (auth)

**11335** YAEC-176
Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.
QUARTERLY PROGRESS REPORT FOR THE PERIOD OCTOBER 1 TO DECEMBER 31, 1959. H. E. Walchli. Feb. 15, 1960. 36p. For Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. OTS.

The autoclave testing of prototype fuel assemblies was completed. A riveted control rod transition joint was designed to provide additional strength. The net influence of flow distribution on core enthalpy rise has shown that estimates used in core design are conservative. A prototype control rod was successfully extruded and surface machined. The in-pile loop experiment began operation but was terminated as a result of a loss of coolant flow accident. (For preceding period see YAEC-169.) (W.L.H.)

**11336**
STUDY OF MARINE REACTORS. Atom, No. 39, 1-32 (1960) Jan.

A study was made of the gas-cooled graphite-moderated reactor, the gas-cooled heavy-water-moderated reactor, the pressurized water reactor, the boiling water reactor, and the organic-liquid-moderated reactor relative to their application in marine propulsion. Descriptions of the reactors as propulsion units of 22,000 shp for 65,000 dwt tankers are given. A comparison of design features and safety requirements of each system is discussed. The capital and operating costs of each system are compared. (C.J.G.)

**11337**
THE EFFECT OF REACTOR TEMPERATURE CHARACTERISTICS ON THE CHOICE OF AN ATOMIC POWER STATION OPTIMAL THERMODYNAMIC CYCLE. D. D. Kalafati. Atomnaya Energ. 8, 5-14(1960) Jan. (In Russian)

Temperature variations in nuclear power installations were studied as functions of the reactor power, using two maximum temperatures for fuel element surfaces and centers. An analysis is made of possible thermal and electrical efficiencies in relation to thermodynamic cycle parameters. Formulas are derived for maximum reactor thermal capacity and steam generator efficiency. Descriptions are given of conditions under which the derived formulas can be applied, eliminating preliminary calculations of thermodynamic cycle parameters. The analysis indicates that future possibilities of increasing the parameters and efficiency of nuclear power plants are dependent upon fuel and cladding materials. (tr-auth)

**11338**
JAPAN'S FIRST NUCLEAR POWER STATION. 1. ENGINEERING DESIGN. P. A. Lindley and K. J. Mitchell (General Electric Co., Ltd., [Erith, Kent, Eng.]). Nuclear Power 5, No. 47, 104-7(1960) Mar.

The gas-cooled graphite-moderated 150-Mw reactor at Tokai-Mura, Japan, is described. Site characteristics and construction problems are discussed. The aseismic fuel element, steam cycle and gas circulator drive, and the radiation shielding designs are discussed. The special features incorporated in the structure of the reactor core, pressure vessel, and gas ducts against earthquakes are described. The design performances of the Hunterston and Tokai-Mura stations are compared. The safety and control features of the reactor are discussed. The principle nuclear parameters are presented in tabular form. A drawing is contained showing a cutaway view of the reactor and associated components. (C.J.G.)

**11339**
ORGANIC-MODERATED MARINE REACTOR TRANSIENTS. G. M. Bracewell (Atomic Power Constructions Ltd., [Eng.]). Nuclear Power 5, No. 47, 126-9(1960) Mar.

The permissible values of control parameters relative to transient (boiling) heat transfer in an organic-moderated marine reactor were studied. Reactivity rates, control rod worth, and coolant flow were evaluated relative to safety and transient performance of the reactor. (C.J.G.)

**11340**
FEASIBILITY STUDY OF ATOMIC POWERED ROCKETS. Gordon H. Miller (Univ. of Michigan, Ann Arbor). Presented at the ARS 14th Annual Meeting, November 16-20, 1959, Washington, D. C.) New York, American Rocket Society, 1959. 77p.

A feasibility study of atomic powered rockets was made. Calculations were made of the size, weight, and characteristics of component parts and of the assembled rocket which is capable in single stage of attaining escape velocity (36,700 ft/sec). Several propulsion systems were examined and the one chosen utilizes a thermal nuclear reactor to heat ammonia to 6000°R. Four assumed rockets having total weights, including working fluid, from 63 to 314 tons were evaluated to determine the minimum size and the allowable payload for the escape rocket. The working fluid quantity, reactor size, structural material and weight, biological shielding and payload were determined. The critical mass and consumption of U-235 were calculated for the largest assumed rocket. (auth)

**11341**
IMPROVEMENT IN THE CONSTRUCTION OF THE DISTRIBUTING AND COLLECTING VESSELS FOR THE COOLING MEDIUM IN HETEROGENEOUS NUCLEAR REACTORS. (to Allmänna Svenska Elektriska Aktiebolaget). British Patent 829,165. Feb. 24, 1960.

A coolant distribution head and collecting vessel for reactors in which the fuel elements are contained in pressure tubes are described. The pressure tubes are fitted in holes in the head by bushings, and the collector is within this head but thermally insulated from it. (T.R.H.)

**11342**
IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. William Bateman Hall. (to United Kingdom

Atomic Energy Authority). British Patent 829,436. Mar. 2, 1960.

A fuel element design is described in which a central fuel rod is surrounded by six stumpy graphite fins, the whole being clad in a protective sheath. The graphite fins improve heat transfer and give support. (T.R.H.)

**11343**

NUCLEAR REACTOR. (to U. S. Atomic Energy Commission). British Patent 829,661. Mar. 2, 1960.

A reactor design is described in which advantages of homogeneous and heterogeneous reactors are combined. The core consists of 19 Zr wire baskets which contain the U Pellets. A mechanism for charging the pellets into the baskets is provided. The core vessel is filled with $D_2O$ containing U and $D_2SO_4$ which moderates and cools the fuel and is passed through heat exchangers and separation equipment. Undissolved pellets are removed at the bottom and reprocessed. The coolant-moderator solution is continuously processed for removal of Pu and fission products and reconstitution. (T.R.H.)

**11344**

IMPROVEMENTS IN AND RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Hugo Heinrich Ludolf Ritz (to C. A. Parsons & Co., Ltd.). British Patent 829,779. Mar. 9, 1960.

A fuel element design is offered in which the rod is knurled or roughened at the ends before cladding. The cladding is then hydraulically pressed on to give good contact. This procedure avoids local stress concentration. (T.R.H.)

**11345**

IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR INSTALLATIONS. Samuel Brittan Hosegood and Joseph Henry Swain (to United Kingdom Atomic Energy Authority). British Patent 829,958. Mar. 9, 1960.

A system for maintaining the liquid level constant in fluid fuel reactors is offered. A dump tank located below the coolant circuit is connected to the high-pressure side of a balancing system. The coolant circuit is connected to the low side. The pressure balancing system consists of a gas compressor with a blow-off valve. (T.R.H.)

**11346**

IMPROVEMENTS IN OR RELATING TO FUEL FOR NUCLEAR REACTORS. David Rowland Morris (to United Kingdom Atomic Energy Authority). British Patent 830,378. Mar. 16, 1960.

A device is described which uses the process of patent no. 830,379 to produce carbon impregnated with fissile material. The device consists of a cylinder closed by bolted plates which have an opening for a carbon rod heater. Valves and connectors for charge, flush, and discharge operations are provided. In operation the device is charged with a solution of 450 g of $UO_2(NO_3)_2$ in 11 of TBP mixed with oil. The temperature of the carbon rod is maintained at 400°C while the mixture is circulated over it. The oil present in a 49:1 ratio carbonizes on the C rod taking down U with it. The U-impregnated carbon thus produced can be graphitized by heating at 2500°C. (T.R.H.)

**11347**

IMPROVEMENTS RELATING TO PROTECTIVE APPARATUS FOR GAS COOLED NUCLEAR REACTORS. (to British Thomson-Houston Co., Ltd.). British Patent 830,661. Mar. 16, 1960.

A control device for gas-cooled reactors is described which operates on a difference signal between reactor power and total gas flow. Inductor-type alternators provide a voltage proportional to the speed of the circulator by means of teeth on one of the couplings between motor and blower. This signal is compared to a reactor power signal and causes shutdown of the reactor upon failure of a blower. (T.R.H.)

## Production Reactors

**11348** CF-60-3-10

Oak Ridge National Lab., Tenn.

EFFECTS OF FAST NEUTRON REACTIONS IN THE BERYLLIUM REFLECTOR OF THE HFIR. H. C. Claiborne. Mar. 4, 1960. 16p. OTS.

The effects of fast neutron reactions in the beryllium reflector of the High Flux Isotope Reactor (HFIR) are discussed. Gas formation in the beryllium appears to limit the lifetime of the beryllium reflector. A comparison of calculations on the HFIR with experimental data from the MTR indicates that the innermost ring of the reflector may require replacing in as little as six months. Estimates of the poisoning effect of $Li^6$ and $He^3$ and the reactivity effect of the (n, 2n) reaction indicate that the net reactivity decrease will not exceed 2% for the beryllium lifetime. (auth)

**11349** HW-25038

Hanford Works, Richland, Wash.

A DESCRIPTION OF THE ACETONE-DYE SOLUTION METHOD OF DEMARCATING A LEAK IN PROCESS TUBING WHILE IN THE PILE. W. R. DeHollander. July 16, 1952. Decl. Mar. 3, 1960. 3p. OTS.

A method was devised and successfully used for marking a leaking pile process tube prior to its removal from the pile, such that subsequent location of the leak is more easily accomplished. An acetone solution of Testor's Dark Red Airplane Dope is poured into the suspect tube. The solution leaks from the hole, and stains the surrounding area a light pink. To date the method has been used on tubes 3573F, 0486F, 0867F, and 3670F. (auth)

**11350** HW-59752

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

1706 KE WATER TREATMENT FOR OUT-OF-REACTOR TEST FACILITIES. T. F. Demmitt. Mar. 30, 1959. 8p. Contract AT(45-1)-1350. OTS.

Water treatment methods used in out-of-reactor loops in the 1706 KE Building are described. Data obtained during operation of these loops indicate that both the corrosion equipment prototype feed and bleed method and the experimental loop mock-up ion exchange methods for loop water purification are satisfactory. (J.R.D.)

**11351**

A GASEOUS-FUEL FAST BREEDER REACTOR. Frederick G. Hammitt (Univ. of Michigan, Ann Arbor). Nuclear Power 5, No. 47, 125-6(1960) Mar.

The feasibility of a gaseous uranium hexafluoride fueled fast breeder reactor using sodium cooling is discussed. The major difficulty appears to be the mechanical complexity involved in a very large number of small-bore tubes for containing the $UF_6$, which must be either individually valved-off or connected into a high-pressure header. (C.J.G.)

## Research Reactors

**11352** CF-60-2-61

Oak Ridge National Lab., Tenn.

NATURAL CIRCULATION BURN OUT HEAT FLUX FOR THE ORR. J. F. Wett, Jr. Feb. 15, 1960. 23p. OTS.

Natural circulation flow rate is calculated for the ORR core. From this flow rate, the burn out heat flux is found to be between 22,000 and 35,000 Btu/ft$^2$-hr. It is concluded that under present conditions a positive acting after heat removal system is necessary for 30 Mw operation. (auth)

**11353** TID-7585(p.40-9)
Massachusetts Inst. of Tech., Cambridge.
REACTORS AS RADIATION SOURCES. Theos J. Thompson. 10p.

The nuclear reactor is a source of neutron and gamma radiations, as well as heat. The main function of the neutrons in the reactor is to keep the chain reaction and hence the reactor going. However, there are sufficient excess neutrons produced during normal operations to serve for special irradiation purposes. Neutrons are not used for the irradiation of food materials since they will make the materials radioactive. Neutrons which have leaked to the edge of a reactor may be captured in a blanket surrounding the core which contains a material with strong-neutron-absorbing properties. The neutron-absorbing material must contain compounds which are soluble in water or some other reasonable solvent. The half life of the material must be of the order of or greater than the length of time required to pump it from the blanket to the irradiator and back to the blanket, but it should not be too long. Gamma rays are produced during the fission reaction and decay of fission products. In the reactor they are mixed with neutrons. In order to produce clean radiation, it is necessary to separate the gamma rays from the neutrons. This may be accomplished in a number of ways, some of which are reviewed. Reactors may then serve as gamma sources for the irradiation of food and other materials, and for other purposes. They may best be used for the irradiation of large samples. Undoubtedly, their most economic use would be in conjunction with the nuclear reactor power program, either employing the spent fuel rods or blankets for irradiation sources. During the next few years, it is likely that reactors will become important sources of high intensity gamma rays for irradiation purposes. It is likely that these irradiation uses and facilities will be developed on a large scale as a by-product of the power production industry. As such, they will result in little additional cost to the power plant and help to make nuclear power economically competitive earlier. (auth)

**11354**
THE SWIMMING POOL REACTORS OF 1000 KW, MELUSINE AND TRITON. I. GENERALITIES. J. Sauvinet and A. Virnot (INDATOM, Paris) and M. Trioulaire (Commissariat à l'Énergie Atomique, Paris). Bull. inform. sci. et tech. (Paris) No. 35, 3-8(1959) Dec. (In French)

The general characteristics, experimental capabilities, and startups of the Melusine and Triton 1000-kw swimming pool reactors are described. The reactors use MTR-type fuel elements and achieve a nominal flux of $10^{13}$/cm$^2$/sec. Experience with the reactors is summarized. (T.R.H.)

**11355**
THE SWIMMING POOL REACTORS OF 1000 KW, MELUSINE AND TRITON. II. NEUTRON STUDY. J. Cherot and B. Sautiez (Commissariat à l'Énergie Atomique, Paris). Bull. inform. sci. et tech. (Paris) No. 35, 9-24(1959) Dec. (In French)

The general characteristics of the Melusine Reactor are tabulated as an introduction to the theoretical and experimental study of its neutron characteristics. In the critical mass studies, several critical configurations were established in an infinite medium, two of simple geometry and the others with a very complex geometry. The temperature coefficient was investigated by heating the water in a uniform fashion and measuring the effect of the temperature on the reactivity of the two simple geometric configurations and on the reactor in "normal operation." Study of the reactor in "normal operation" included investigation of the temperature coefficient for uniform temperature, effect of experimental channels on the reactivity, standardization of the control and operating rods, effect of some peripheral elements on the reactivity, distribution of thermal and epithermal neutrons in the core and experimental arrangements, distribution of fast neutrons in the core and reflector, and effect on the reactivity of xenon poisoning during operation of the reactor at 1 Mw for 80 hr. (J.S.R.)

**11356**
THE SWIMMING POOL REACTORS OF 1000 KW, MELUSINE AND TRITON. III. SHIELDING. 1. STUDY OF THE SHIELDING OF THE MELUSINE REACTOR. P. Canel and R. Jouty (INDATOM, Paris). Bull. inform. sci. et tech. (Paris) No. 35, 25-35(1959) Dec. (In French)

The results of theoretical studies of the shielding of the Melusine Reactor are presented. Protection against the core radiation is given by the depth of immersion of the core and the dimensions of the pool. Lateral protection is also offered by the concrete walls. The dimensions of the pool are sketched. The problem of the activation of construction materials is then discussed, with a consideration of the water, the internal walls of the pool, the iron embedded in the concrete, the aluminum claddings, and the plugs. The validity of the theoretical calculations have been verified by experience. (J.S.R.)

**11357**
THE SWIMMING POOL REACTORS OF 1000 KW, MELUSINE AND TRITON. III. SHIELDING. 2. MEASUREMENTS OF THE RADIATION AROUND THE REACTOR. V. Coutrot, J. Delpuech, and L. Fitoussi (Commissariat à l'Énergie Atomique, Paris). Bull. inform. sci. et tech. (Paris) No. 35, 36-7(1959) Dec. (In French)

To compare the theoretical results of the calculations of the shielding of the Melusine Reactor with the actual activity levels found around the reactor, some measurement results obtained during 1-Mw operation are presented. The measurements show that the activity levels do not exceed the tolerance levels and agree with the theoretical predictions in most cases. (J.S.R.)

**11358**
THE SWIMMING POOL REACTORS OF 1000 KW, MELUSINE AND TRITON. IV. THE POOL. G. Coste (Commissariat à l'Énergie Atomique, Paris) and J. P. Toubiana (INDATOM, Paris). Bull. inform. sci. et tech. (Paris) No. 35, 38-46(1959) Dec. (In French)

The depth of the pool is fixed by the height of water necessary for shielding. The side dimensions are determined by the utilization of the reactor and the dimensions of the body to be submerged. The basis of the calculations made on the dimensions of the pool, the materials used, and the construction is reviewed. The "Grands Travaux de Marseille" procedure of prestressing was used for the Melusine and the Freyssinet procedure for the Triton. The characteristics of the concretes used are given. Tests for water tightness and methods for the evaluation of water losses are described. The apparatuses which pass through the walls or which are placed in the concrete are discussed and the restrictions imposed on the engineering by their presence are considered. (J.S.R.)

**11359**
THE SWIMMING POOL REACTORS OF 1000 KW, MELUSINE AND TRITON. V. THE CORROSION PROBLEMS IN THE SWIMMING POOL REACTORS. H. Coriou (Commissariat a l'Energie Atomique, Paris). Bull. inform. sci. et tech. (Paris) No. 35, 47-52(1959) Dec. (In French)

As aluminum is used for cladding the fuel elements, which are composed of an aluminum—uranium alloy, in the Melusine and Triton Reactors, the corrosion characteristics of aluminum are of importance. A brief survey is made of these characteristics and of the problems likely to be encountered in the operation of the Melusine and Triton. Corrosion of the stainless steel and the fuel is briefly mentioned. (J.S.R.)

**11360**
THE SWIMMING POOL REACTORS OF 1000 KW, MELUSINE AND TRITON. VI. PURIFICATION OF THE WATER AND CASING. P. Caron (INDATOM, Paris) and R. Platzer (Commissariat à l'Énergie Atomique, Paris). Bull. inform. sci. et tech. (Paris) No. 35, 53-60(1959) Dec. (In French)

The principal characteristics of the water of swimming pool reactors are considered with respect to the requirements of biological protection, flexibility of utilization, neutron moderation, and corrosion. The two procedures generally utilized in the purification of water are distillation and ion exchange columns. The reasons for the choice of ion exchange columns for use in the Melusine and Triton are discussed, and the installations are described. The regeneration of the ion exchangers in the filling circuits and the purification circuits is discussed. The operation of the filling and purification circuits is satisfactory after a year's experience. Casings are used in swimming pool reactors to prevent the pollution of the water by the concrete and not the corrosion of the concrete by the water. The types of casings used, metallic, elastomer veneers, continuous films, and ceramic are described, and the advantages and disadvantages are analyzed. In Melusine the casing is formed of tiles of enameled sandstone joined with a polyester resin. In Triton a ceramic casing joined with araldite is used. The behavior of each is briefly described. (J.S.R.)

**11361**
THE SWIMMING POOL REACTORS OF 1000 KW, MELUSINE AND TRITON. VII. THERMAL EXCHANGES. REFRIGERATION INSTALLATIONS. G. Halbronn (SOGREAH, Paris) and A. Peuchmaur (INDATOM, Paris). Bull. inform. sci. et tech. (Paris) No. 35, 61-70(1959) Dec. (In French)

The thermal exchanges occurring in swimming pool reactors are discussed theoretically with respect to transitory regime after disconnection of the pumps and permanent regime with natural convection. The refrigeration installations for forced circulation in Melusine and Triton Reactors have a primary and secondary circuit. The characteristics of the secondary circuits are tabulated, and then the primary circuits are described in detail. (J.S.R.)

**11362**
THE SWIMMING POOL REACTORS OF 1000 KW, MELUSINE AND TRITON. VIII. CONTROL. P. Jover and J. Weill (Commissariat a l'Energie Atomique, Paris, and C. Samuel and R. Sigelle (INDATOM, Paris). Bull. inform. sci. et tech. (Paris) No. 35, 71-86(1959) Dec. (In French)

The control of the Melusine and Triton is obtained principally by a series of measurements of the neutron flux and by a system of manual or automatic operation of the absorbing rods in the core which permits the neutron flux to be stabilized at a predetermined value. A general description is given of both controls. A theoretical study is given of automatic operation. The classical measurements for the control of the coolant and purification circuits are then discussed. The radiation monitoring and safety devices of the reactors are described. (J.S.R.)

**11363**
THE SWIMMING POOL REACTORS OF 1000 KW, MELUSINE AND TRITON. IX. SIX MONTHS OF EXPLOITATION OF MELUSINE. Y. Droulers and F. Rossillon (Commissariat à l'Energie Atomique, Paris). Bull. inform. sci. et tech. (Paris) No. 35, 87-97(1959) Dec. (In French)

The results of the first six months of operation of Melusine from March 13 to September 15, 1959, are reported with respect to the actual performance of the reactor and to its utilization. (J.S.R.)

**11364**
METHODS OF CHOOSING THE CHARACTERISTICS OF A MATERIALS TESTING REACTOR. Wacław Frankowski (Instytut Badan Jadrowych PAN, Warsaw). Nukleonika 4, 491-504(1960). (In Polish)

A review of materials testing reactors is given, and the reactors are compared with requirements for an "ideal materials testing reactor." Methods of approximating the characteristics of a materials testing reactor are discussed. (C.J.G.)

# WASTE DISPOSAL AND PROCESSING

**11365** AWRE-O-32/56
United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England.
PHYSICO-CHEMICAL INVESTIGATIONS INTO THE ABSORPTION AND REMOVAL OF RADIOISOTOPES FROM TEXTILES. PART 2. CAESIUM, TELLURIUM AND IODINE ON COTTON. D. G. Stevenson. Oct. 1956. 23p.

The behavior of cesium, tellurium, and iodine in cotton relative to absorption and removal was studied. Cotton exhibits only a slight affinity for cesium. Absorbed cesium may be readily removed by water or a simple buffer solution. Tellurium and iodine in an anionic form are not absorbed, and "dried on" contamination is easily washed out by water. Under acid conditions, either during contamination or decontamination, these elements tend to become more firmly fixed. Tellurium is precipitated in and on the fabric in the form of the dioxide, which is removed only by alkaline treatments. Iodine is also less easily removed when allowed to "dry on" under acid conditions, or when decontaminated under similar conditions. (auth)

**11366** CEA-1197
France. Commissariat à l'Énergie Atomique, Paris.
TRAITEMENT ET STOCKAGE DES MATERIELS CONTAMINES. (Treatment and Storage of Contaminated Materials). P. Cerre and J. Pomarola. 1959. 13p.

The ultimate disposal of radioactive wastes sets an important problem which has been partly solved. France has temporarily adopted a method which involves volume reduction, and fixation of the activity in non-leachable solids which can endure all kinds of storing. According to two basic principles, a decontamination plant allowing maximum recovery of materials, and the plans of an installation devised for carrying out radioactive waste volume reduction and conditioning are underway at Saclay. (auth)

**11367** DL(S)TN-2009
Gt. Brit. Springfields Works, Springfields, Lancs, England.
ION EXCHANGE AND FACTORY EFFLUENT TREATMENT. G. I. Goodfellow, G. V. Francis, and J. A. Dukes. Nov. 29, 1951. 11p.

Laboratory-scale experiments with ion exchange resins are described and the value of resins for uranium recovery from Springfields Factory effluents is discussed. There is now evidence that neither anion nor cation exchangers will be of value for primary stages of recovery from effluents. The conditions required for effective use of strong-base anion exchangers are being quantitatively ascertained, so that these resins might be used for other essential stages of recovery. As soon as the limitations of the ion exchangers were seen from these experiments, work was started on other methods of treating Factory effluents. (auth)

**11368** HW-60614
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
PHYSICAL PROPERTIES OF NEUTRALIZED ZIRFLEX WASTE. L. C. Amos. June 8, 1959. 5p. Contract AT(45-1)-1350. OTS.

An investigation was made to determine the physical properties and flow characteristics of the neutralized slurry to assist in the selection of satisfactory transfer equipment and storage conditions. The neutralized Zirflex waste slurry contains 20 vol. % rapidly settling solids. It can be transferred easily if the flow is in the turbulent condition, but agitation is needed during temporary storage. Pipe lines should be flushed with water after transfer of the waste slurry. (W.L.H.)

**11369** NAA-SR-Memo-4559
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
WASTE WATER DECONTAMINATION. R. G. Kellehar and J. D. Moore. Oct. 26, 1959. 15p. OTS.

An investigation to determine the decontamination factors associated with the filtration of waste water containing uranium and mixed fission products is described. This work is part of a study on the feasibility of using filtration as a method for decontamination of waste water at the Santa Susana and DeSoto Facilities. Preparation of alpha self-absorption curves is described. (J.R.D.)

**11370** NSEC-12
Nuclear Science and Engineering Corp., Pittsburgh.
RETENTION EFFICIENCIES OF SELECTED ADSORBENTS FOR KRYPTON. R. C. Koch and G. L. Grandy. Apr. 15, 1958. 40p. OTS.

An investigation was undertaken to determine the retention efficiencies of selected adsorbents for Kr in a stream of nitrogen. The adsorbents studied were carbons, minerals, and inorganic compounds. (W.L.H.)

**11371** ORNL-2872
Oak Ridge National Lab., Tenn.
REMOVAL OF RADIOIODINE FROM AIR STREAMS BY ACTIVATED CHARCOAL. R. E. Adams and W. E. Browning, Jr. Apr. 1, 1960. 13p. Contract W-7405-eng-26. OTS.

Contamination of the atmosphere by radioactive isotopes of iodine constitutes a serious biological hazard and, for this reason, provisions should be made at reactors to prevent such releases in the event of an accident. The efficiency of activated charcoal for adsorption of iodine vapor from air streams was measured by using a radioactive tracer method, and efficiencies of 99.6 to 99.999+% were obtained for various conditions. Comparative tests were run with silver-plated copper ribbon. A criterion for selecting an iodine removal material was developed based on efficiency and resistance to air flow. The iodine vapor adsorption efficiency of a commercial charcoal filter was measured. Various materials were considered for possible application in the emergency exhaust system of the building housing the 5-Mw swimming pool reactor at the Puerto Rico Nuclear Center. Based upon its high adsorption efficiency and retention properties, it is proposed that activated charcoal be utilized for iodine vapor adsorption. (auth)

**11372**
THE EXAMINATION OF THE VISTULA WATER WITHIN THE BOUNDARIES OF GREATER WARSAW. Witold Hermanowicz, Stanisław Guberski, Władysław Gutowski, Zbigniew Szperliński, and Ewa Wróblewska (Politechnika, Warsaw). Nukleonika 4, 557-66(1960). (In Polish)

Levels of $P^{32}$, $Sr^{89}$, $Sr^{90} + Y^{90}$, $I^{131}$, $Cs^{137} + Ba^{137}$, and $Ce^{144} + Pr^{144}$ in the Vistula River are tabulated as counts per liter. All specimens were taken within the bounds of Warsaw. (D.E.B.)

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